THE TRANSFORMATION OF FORD

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A STRATEGY TO IMPROVE URBAN MOBILITY WITH AUTONOMOUS VEHICLES

Graduation thesis

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"Cities themselves are mobility systems, giant machines to serve the needs of the people who live and work in them. They whirr and clackle along with trains, subways, buses, boats and trams, and more private taxis, motorbikes and personal cars. Around the machine, people walk and cycle, inserting themselves into the flow like ants, checking every space for the best way through."

- Smith & Vardhan (2017)

PREFACE

I would like to welcome you to this master thesis that finalizes my journey as a master student at the faculty of Industrial Design Engineering at the Technical University of Delft. This last semester was a whirlpool where I dove into the field of mobility, almost drowned, but kept my head above water. At this moment, while writing the preface of my master thesis, I am comfortably swimming towards to end.

As this thesis will explain, collaboration and teamwork are important factors in creating value. The value of this thesis is also not created alone but with the help of a lot of people who I would like to thank. First of all, my parents for always supporting me in every way imaginable, thank you. Of course, also my sister for all the 'Friends' questions and your scientific knowledge during this project. I would also like to thank my friends and the other graduation students, hearing all the stories and helping me if needed. Especially Arne, for providing the 'Koffie pas' and all the brakes that followed. Also, thank you Leroy, Jan, Emma, Nick & Martijn for reading through this stack of paper and providing your critical view and many jokes.

Second, I would like to show my gratitude to the graduation team. Dirk, for all our conversations about everything (Brabant) on top of the graduation assignment. Maaike, for all the support dispite your busy schedule. Thank you for providing critical but constructive feedback, even during the Olympic games. I would also like to thank the team at Ford and especially Nicole, for the meetings all the way in Delft and the Christmas market in Aachen.

Third, this thesis would not have been possible without the collaboration and willingness of all experts and stakeholders. Thank you for providing your knowledge and insights on this topic and giving me the opportunity to design strategic solutions for Ford. Especially, I would like to thank Jeroen for his expertise in 'Visual Thinking' and the time he put in this project.

Finally, thank you Bianca. For all your loving care and so much more during this project.

Now, let's read something academic.

Ruben Verbaan
02 - 03 - 2018
Delft

STAKEHOLDERS

EXPERTS

EXECUTIVE SUMMARY

Transformation of the mobility industry

With increasing globalization and urbanization, space in urban areas is very limited and air quality is decreasing because of fossil fuelled engines. Since the invention of the automobile in the early 1900's, the automotive industry currently faces their biggest disruption so far. With automation, digitization and electrification, the automotive industry can offer Mobility as a Service in collaboration with other mobility providers.

Transformation of Ford

Currently, Ford's value to the ecosystem is the product (vehicle). In order to offer Mobility as a Service, Ford needs to work together with other stakeholders in the mobility ecosystem. Only then, users can experience the efficiency of shared mobility from A to B. Moreover, if Ford is able to collaborate with other mobility providers and stakeholders of the ecosystem, space in urban environments can be regained, giving the streets back to the community. This fits with Ford's vision of democratizing mobility.

Design approach

In order to achieve this, I have emerged myself in the complex ecosystem of mobility and found different variables that are of influence when designing for urban mobility. I interviewed experts in the field of new mobility solutions and visited multiple stakeholders of the mobility ecosystem in order to formulate a founded vision on urban mobility (see Figure 1). From this vision, I subtracted new strategic mobility solutions for Ford in order to anticipate for the future ecosystem of urban mobility.

Scope

The scope for the assignment is Eindhoven in the Netherlands. Eindhoven has a car friendly infrastructure and is relatively small enough for quick iterative testing of new technologies with the automotive campus nearby. Also, stakeholder position possitive towards mobility initiatives. Finally, Eindhoven is also far ahead compared to other European cities in Smart Mobility initiatives.

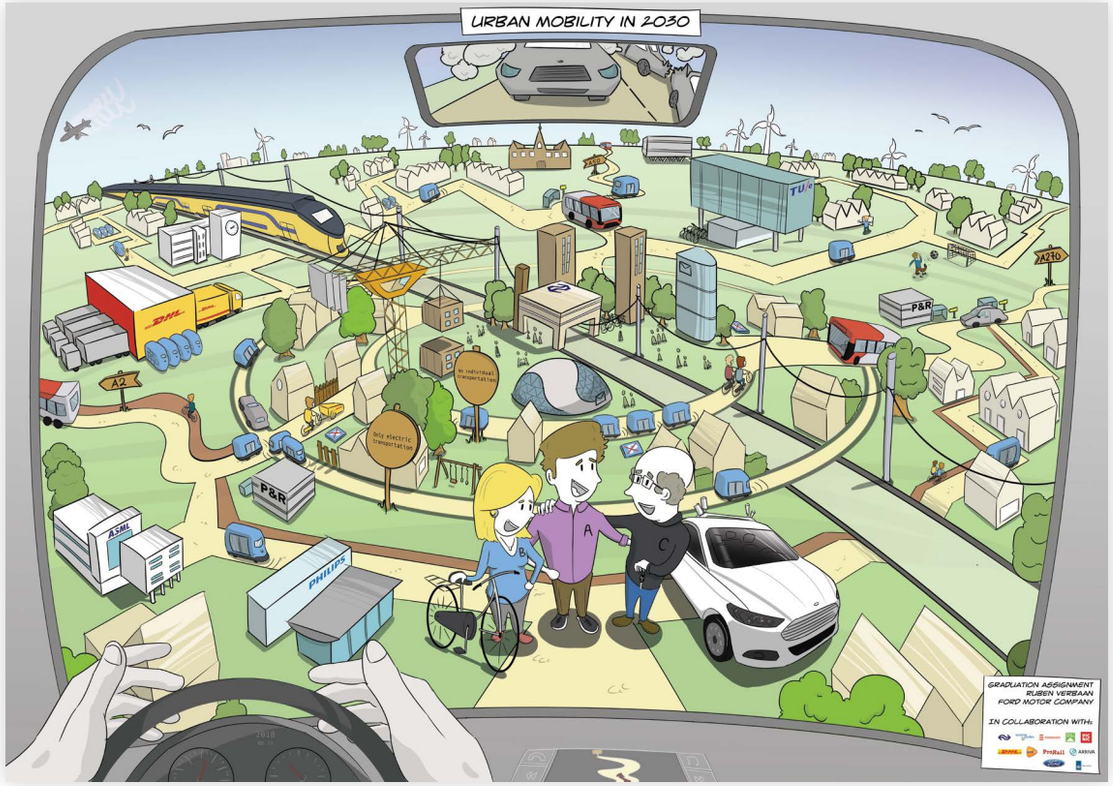

Figure 1. Vision on urban mobility

Envisioning the future of urban mobility

The method of 'Visual Thinking' is used in order to communicate my vision for future urban mobility. This vision is iterated with stakeholders and validated with Ford. The visualization of the vision has several layers of information.

1. **Car metaphor** (rear-view mirror is the past, inside the car is the present, in the window in the future)
2. **Urban zones** (zone A: Downtown, zone B: Pre-war, zone C: Suburbs)
3. **Dominant transportation modes** (zone A: walking, zone B: biking, zone C: driving)
4. **Mobility users** (people transport, goods & services, construction & maintenance)

Strategic mobility solutions for Ford

From this vision I created multiple mobility solutions. Finally, I recommend the three most viable, desirable and feasible solutions:

1. First and last mile transportation in collaboration with busses;
2. Dedicated autonomous areas;
3. Autonomous goods delivery.

These solutions perfectly fit Ford's vision of democratizing mobility and enable Ford to implement emerging mobility technologies correctly and prepare itself for the transformation of the mobility industry.

ABBREVIATIONS

ABBREVIATION	TERMINOLOGY
A V	Autonomous Vehicle
O E M	Original Equipment Manufacturer
A I	Artificial Intelligence
I o T	Internet of Things
V 2 V	Vehicle to Vehicle communication
V 2 I	Vehicle to Infrastructure communication
V 2 X	Vehicle to Everything communication
M o D	Mobility on Demand
M a a S	Mobility as a Service
F M R	Ford Mobility Research
A C D	Advanced Concept Design
B 2 B	Business to Business
B 2 C	Business to Consumer
C E S	Consumer Electronics Show

GLOSSARY

Mobility as a Service

"The integration of various forms of transport services into a single mobility service accessible on demand. The aim of Mobility as a Service (MaaS) is to provide an alternative to the use of the private car that may be as convenient, more sustainable, help to reduce congestion and constraints in transport capacity, and can be even cheaper" (www.maas-allience.eu).

Praatplaat

(visual thinking illustration)

A type of visualization used in industry to communicate abstract terms (e.g., visions or strategies). It often consists of metaphors and analogies for explicit interpretation.

Stakeholder

Shareholders or a person or group not owning shares in a company or organization but affected by or having an interest in its operations.

Pre-war area

The urban pre-war area is the environment designed before the second world war. Cars became popular for the public after this time. Therefore, the Pre-war area is not designed for cars which causes a shortage in space today.

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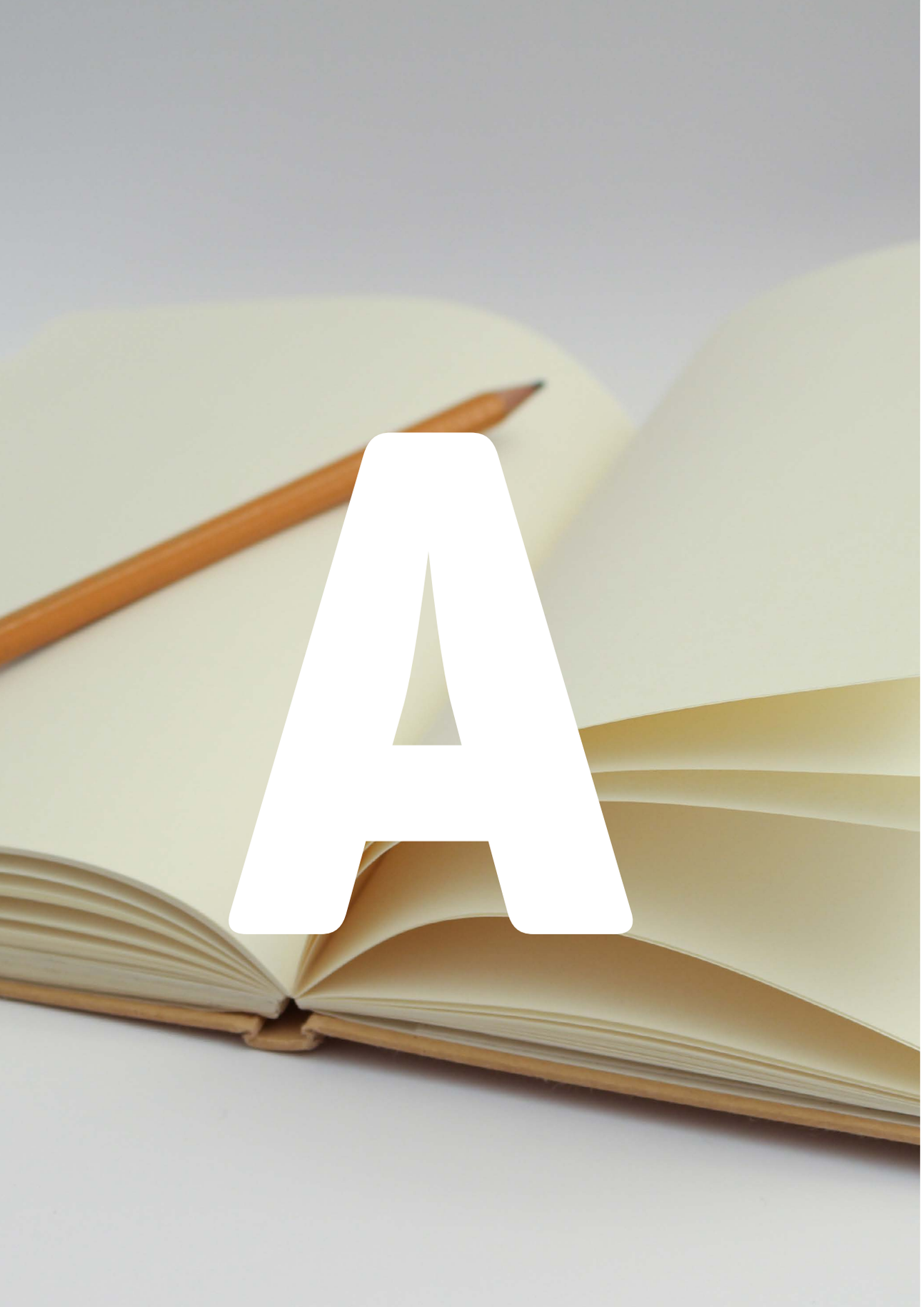


DESIGN CONTEXT

In order to understand the reasoning behind this assignment, the first part of this master thesis will introduce Ford and their motivation for the graduation project. Also, part A will clarify the change that is happening in the mobility industry and how Ford should adapt to this change. Finally, I elaborate on the specifics of the design approach and how I have tried to understand and design for this change. This will give an understanding of the scope and context of this thesis.

1. INTRODUCTION

Raison d'être master thesis

Ford is heavily investing in autonomous vehicles (www.corporate.ford.com). They promise an autonomous fleet that is able to perform in all aspects of the dynamic driving tasks, even if a human driver does not respond to a request to intervene (Warrendale, 2014), to be available at 2021. Currently, Ford is one of the frontrunners in autonomous technology (Navigant Research, 2017). Yet to make this happen, Ford needs more knowledge on possible opportunities with the implementation of this technology to improve urban mobility.

Ford is currently involved in a University Research Program (URP) together with the faculty of Industrial Design Engineering (IDE) at the Technical University of Delft. The goal of the URP (with the title: 'Service Innovation for Mobility: Sensing deep customer insights and seizing creative opportunities for new mobility services') is to improve co-design activities for future services, with a focus on autonomous ride hailing and goods delivery. This three-year program should answer how state of the art methods for generating deep customer insights inform the exploratory prototyping of solutions for future contexts. This graduation assignment is the first part of the URP which focusses on creating a holistic view of relevant stakeholders in urban areas.

To design for the future is to make assumptions on several possibilities. For the purpose of this assignment, Ford has given the assumption that they will have the technology for autonomous vehicles (AVs) readily available for the timline of this project (2030).

Problem definition

Ford's core capabilities lie in technological developments of the vehicle. With the technology driven radical innovation opportunity of autonomous vehicles, Ford needs to extend their capabilities towards being able to continuously create a holistic view of relevant stakeholders. Also, co-create a new system for mobility solutions in urban environments. In order for Ford to know what value to create, an overview needs to be mapped containing every stakeholder of this new system, including business (e.g., OEM's, public transport, start-ups), organization (e.g., municipalities, universities) and people (e.g., city habitants, visitors, elderly).

The problem is that current mobility providers (e.g., Ford) have too little knowledge of the ecosystem that should deliver Mobility as a Service (with autonomous technology) in the urban environment and the stakeholders that are involved. At the Ford Mobility Research (FMR) department, a dedicated team is already concerned with tests and experiments to learn about this development.

The main research question therefore is:

How can Ford prepare itself and design for the disruptive technology of autonomous vehicles within the mobility ecosystem of 2030? ➤

Assignment

In order to anticipate on the disruptive technology of autonomous vehicles, Ford needs to have knowledge of the system and stakeholders that are involved with mobility in cities. I acquired this knowledge by research of the mobility ecosystem. Also, I involved relevant stakeholders in order to create a holistic view of urban mobility in 2030. With these insights, I designed a strategy for Ford which consists of a proposition on how Ford should position itself within this new system and what kind of solutions (e.g. products/ services/ platforms with stakeholders) they should offer.

With the problem definition and assignment explained, I will elaborate on the transition that Ford is currently facing. Understanding this transition is essential for the assignment as it expains the motivation of Ford to change and the value they want to deliver in the new mobility ecosystem. ■

Figure 2. First assembly line (www.ford.com)

2. BUILD UP

start project

PART A

The first part will explain the scope and context of the assignment. Also, it will elaborate on the tranformation that Ford is currently facing.

DESIGN CONTEXT

· THE TRANSFORMATION OF FORD

· DESIGN APPROACH

PART B

The second part will explore the context of mobility and which variables influence this system. Also, it will elaborate on new mobility technologies.

THE CONTEXT OF FUTURE MOBILITY

· THE MOBILITY ECOSYSTEM

· AUTONOMOUS TECHNOLOGY

ANALYSES

PART C

From the analyses, a vision is designed and iterated with stakeholders of the mobility system. Finally, the vision is validated with Ford.

CO-CREATING THE ECOSYSTEM WITH STAKEHOLDERS

· ITERATIONS OF THE VISION

PART D

The vision on future urban mobility will act as a guideline from which strategic mobility solutions are derived for Ford.

STRATEGIC SOLUTIONS FOR FORD

· STRATEGIC SCENARIOS

· FUTURE MOBILITY OPPORTUNITIES

DESIGN

PART E

This thesis is concluded and the research question is answered.

CONCLUSION

finish project

3. HISTORY OF FORD

Ford is one of the biggest car manufactures in the world (see Figure 3). In 2016, Ford had around seven percent of the global market share (Ford Motor Company, 2016). Ford is one of the oldest automotive family businesses with Henry Ford as its founder, who introduced the first mass production vehicle (see Figure 2) around 1913 (www.corporate.ford.com/history), assembling a vehicle in 1,5 hours instead of 12,5. Therefore, Ford is famous for putting the world on wheels, envisioning the freedom of movement for society. One of Henry Ford's famous quotes is still very relevant today, as new challenges in the mobility industry demand collaboration between stakeholders:

"If everyone is moving forward together, then success takes care of itself"
– Henry Ford

From 1920 until 1990, the industrial age was dominant and its biggest challenge was how to mass produce products, so that everyone who wishes, would be able to identify themselves with new technologies at home (Brand & Rocchi, 2011). Currently, Ford identifies a shift in consumer behaviour as they expect more than just products. They see a transition from their core business (developing products) towards 'Mobility as a Service' (MaaS): *"the integration of various forms of transport services into a single mobility service accessible on demand" (www.maas-allience.eu)*.

Figure 3. Overview of automotive brands (www.businessinsider.com)

The newly appointed CEO, Jim Hackett, has a background in design thinking as he worked with IDEO and is well-known for saving the company Steelcase with his design mind-set. In a recent presentation at CES (Consumer Electronics Show), Hackett explained how he wants to use Henry Ford's mind-set of liberating the freeways for people into the twenty-first century (Hackett, 2018). This transformation is elaborated on in the next chapter. ■

Figure 4. CEO of Ford, Jim Hackett

4. TRANSFORMATION OF FORD

When the automobile was designed, Henry Ford envisioned the freedom of movement for society. In the early years (1900 – 1950), the automobile increased the quality of life for society (e.g., improved accessibility to healthcare or cheaper housing because people could travel longer). Currently, automobiles dominate the streets, creating limitations in human freedom and their connection to society.

"Henry Ford got a lot right. He was right about the freedom of movement. But if he were here he wants to avoid making the mistakes of the industrial age, when the freedom of movement came at the expense of community for a connection to each other." - Hackett (2018)

Ford's vision is therefore to *democratize mobility* and give the streets back to the community. New technological developments enable the opportunity to redesign the current mobility system as Ford envisions. Currently, Ford focusses on the design and production of the vehicle (product) to provide freedom of movement. If Ford wants to democratize mobility, they need to broaden their scope towards *Mobility as a Service*. This change (servitization) describes the process through which originally product oriented companies shift their focus and competitive strategies to services (Togt, 2017).

Servitization of Ford

In order for Ford to deliver value to society, they need to acknowledge a change in the way they do business. Currently, Ford's value creation exists of the production of the product (value in possession). They are responsible that every part of the product is designed, and every co-producer is aligned in the creation of that product. When Ford wants to deliver value with services (value in use), they also need to collaborate with other stakeholders and co-create new mobility solutions for the ecosystem (Vargo & Lusch, 2008).

"For generations, the automotive industry is largely focussed on that object [vehicle], on only that part of the equation. But we know that won't work when it comes to the new Smart Mobility. We need to take this broader system view." - Hackett (2018)

A successful service experience is the outcome of close collaborations between internal and external stakeholders; service innovation is a network activity (Chesbrough, 2003; Lusch & Lubar, 2015). Therefore, Ford cannot deliver *Mobility as a Service* alone. They need other stakeholders to participate in creating value in the ecosystem of mobility.

Value creation in ecosystems

Currently, Ford's ecosystem exists of co-producers of the product. The design of services broadens the scope of the ecosystem with other mobility providers (e.g., public transport) and stakeholders (e.g., municipalities) instead of suppliers. Adner (2016) defines an ecosystem as: *"the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize"*. This definition states that alignment of those stakeholders is essential for providing value (the service). Ford wants to add value to the ecosystem by improving mobility and therefore, the quality of life for society. When innovating for societal challenges, it is important to understand values at different levels (e.g., the user, organization, and societal level) in an extended network of stakeholders (Ouden, 2015).

To conclude, it is essential for Ford to understand value flows for different levels of the complex ecosystem of mobility. Moreover, Ford needs to closely collaborate with stakeholders in order to deliver new mobility solutions (services). ■

5. DESIGN APPROACH

With the transformation in the industry and for Ford explained, I looked into an approach on how to design for this change. First, I looked into the capabilities of designer's and how it can benefit in the context of this assignment. Second, I define an approach that fit these capabilities.

In order to understand the complexitity of the mobility ecosystem, a holistic and user-centred view is favourable. This fits perfectly in a designer's approach for innovation (Stompff, 2012). Moreover, designers have a holistic, solution based strategy to problems which makes room for system thinking (Stompff, 2012), thus they are able to cope with the complexity of ecosystems well. The designerly way of working (user centeredness, collaborativeness and prototyping) has also evolved from product-form-centric design in the industrial era, to experience (value-in-use) design in the service era, and digital era (Calabretta & Kleinsmann, 2017). As the different eras all have their specific characteristics, they can be complementary to each other. Digitization however, makes innovation processes far more complex as there are several layers of messy, ambiguous ecosystems of companies, users, and other stakeholders (Kallinikos, Aaltonen, & Marton, 2013). Therefore, the profession of design transforms from collaborating with stakeholders on a product level (e.g., production facilities), to collaborating with stakeholders on an ecosystem level (e.g., public transport or municipalities). Collaborativeness being one of the core skills of designers, refers to the fact that designers create innovative outcomes through co-creation with relevant stakeholders (Sanders & Stappers, 2008). A designerly approach can facilitate rich conversations that support the alignment of goals, clarifying roles and responsibilities of stakeholders (Kleinsmann, Valkenburg, & Sluijs, 2015). Therefore, designers are a valuable asset in designing new mobility solutions in ecosystems.

Literature on designers' capabilities show that they have the skills to help Ford with this transition. Designers are able to collaborate with stakeholders in co-creating this future ecosystem. This assignment therefore focusses on two activities: (1) understanding the context of the future of mobility and the ecosystem; and (2) co-creating the desired ecosystem with stakeholders. Steps in these activities are derived from previous design research of Evans (2011) and Verganti (2016).

Understanding the context of future mobility

Innovation teams that succeed in creating a shared goal find a delicate balance between diversity and common ground (Kleinsmann et al., 2015). A shared goal within an ecosystem such as urban mobility could be, for example, no pollution or (traffic) congestions. This shared goal can be seen as a common vision: an image or expression of a desired future. Visioning is often seen as the realm of the artist, the poet, the futurist, and the designer (Reid, 2015) as they sometimes come from personal inspiration, intuition, overserved trends or identified opportunities (Simonse, 2017). Designers are skilled in creating common ground as they not only think within the boundaries of the current ecosystem but are able to envision the 'intended' system, also taking on the role of the 'imaginator' (Stompff, 2012).

"We need to align our goals as a society."
- Hackett (2018)

Creating a vision is especially useful when dealing with radical innovation (Verganti, 2016). Innovation is radical when you 'do something that we did not do before', as innovation is incremental when you 'do better than we already know' (Norman & Verganti, 2014). With radical innovation, stakeholders do not know how ecosystems will behave or react as opposed to incremental innovation, where stakeholders can somewhat predict the impact of an improvement. Therefore, a vision is created and communicated with stakeholders about possible implications of the radical innovation, this helped to set shared goals for the mobility ecosystem.

To get a grip on current initiatives on new mobility solutions, I interviewed experts and key-interpreters. Key interpreters are *"forward looking researchers who are developing, often for their own purposes, unique visions about how meanings could evolve in the life context we want to investigate"* (Verganti, 2009). Expert input is used to fill knowledge gaps as well as providing provocative viewpoints or counter arguments (Evans, 2011). Also, it gives the current state of technology initiatives and research done in this area. The insights from this research provided input for the future vision.

Also, I did analyses on the ecosystem to understand the context of the ecosystem and which variables and stakeholders influence the system. As ecosystems are complex, I used knowledge from multiple disciplines (e.g., architects, urban planners, consultants) to create a context and understand how value is exchanged. From these analyses, ➤

trends derived about the consequences of autonomous technology in the ecosystem, for different mobility users and stakeholders.

After the different analyses, expert interviews, and trends research, I created a vision based on my own intuition about the future of mobility and stakeholders involved. This intuition enables designers to empathize with the future (Evans, 2011). A vision should have four characteristics: (1) clarity; (2) value drivers; (3) artefact; (4) magnetism (Simonse, 2017).

1. **Clarity** of the vision means that the vision expresses immediate understanding of how someone would experience that future (Reid, Roberts, & Moore, 2015; Shipley, 2002);
2. **Value drivers** are the key benefits of the vision. It should be clear what problem or dilemma is solved (Heinonen & Hiltunen, 2012);
3. **Artefact** is the object through which the vision is materialized (Meija Sarmiento, Simonse, & Hultink, 2015);
4. **Magnetism** states that the vision should be attractive, desirable and passionate, being able to activate others to action (Reid et al., 2015).

The vision for this project is not a product or corporate vision, it is a vision of a complete ecosystem: urban mobility. Therefore, visual communication (e.g., sketching) is used as an (3) artefact, to create (1) clarity of the ecosystem.

Significant research is done within the field of visual communication and the added value of sketches in the design process. Sketches allow creative reinterpretation (Christensen & Schunn, 2008) that can be used to show design solutions, but also conflicts and possibilities (Dym, Agigino, Eris, Frey, & Leifer, 2005). Sketches are easier to interpret than text (Arntz, Verbaan, Eisenbart, & Cardoso, 2017) and are essential when trying to convey ideas and information. Therefore, it is a predominant activity for the designer (McGown, Green, & Rodgers, 1998). Within stakeholder alignment, sketches create a better understanding and immediate interest, as it looks more desirable (4, magnetism) than text.

For this assignment, a vision is sketched of the mobility ecosystem. Different stakeholders within this ecosystem will be drawn in an abstract way, clearly showing the (2) value drivers. This form of sketching is often seen in design strategy consultancies (e.g. INKstrategy and JAM) where complex abstract information, such as a vision, can be drawn into a ‘Praatplaat’ or ‘Visual Thinking illustration’ (see Figure 5). These complex multi-interpretable visions are often displayed in metaphors or analogies in order to align internal and/ or external stakeholders behind one vision.

Co-creating the ecosystem with stakeholders

Different perspectives of stakeholders form barriers for innovation (Carlile, 2002). A lack of shared understanding between stakeholders causes unnecessary iterative loops (Valkenburg & Dorst, 1998) which ultimately could reduce the quality of the final product, because not all problems have been solved (Dong, 2006). As such, it was vital in this project that the vision is iterated together with

Figure 5. Example Praatplaat (Liende van der, 2017)

relevant stakeholders in order to capture the right perspective.

The process of Verganti (2016) explained that after someone had reflected individually on his vision (or innovation of meaning), he seeks out criticism (someone who is able to judge, value, interpret) in order to constantly improve and iterate on his personal vision. For this assignment, I discussed my vision with multiple stakeholders in the field of mobility (e.g., public transport providers and municipalities) in order to iterate and validate my vision. This allowed me to develop collaborations with stakeholders to co-create a desired future and investigate a position for Ford in the ecosystem of Mobility as a Service.

A future proof strategy for Ford

Finally, I looked for strategic directions for Ford to innovate and further investigate in order to improve urban mobility in the future. With this strategy, opportunities are explained for new mobility solutions that emerge from new technologies (e.g., autonomous vehicles). ■

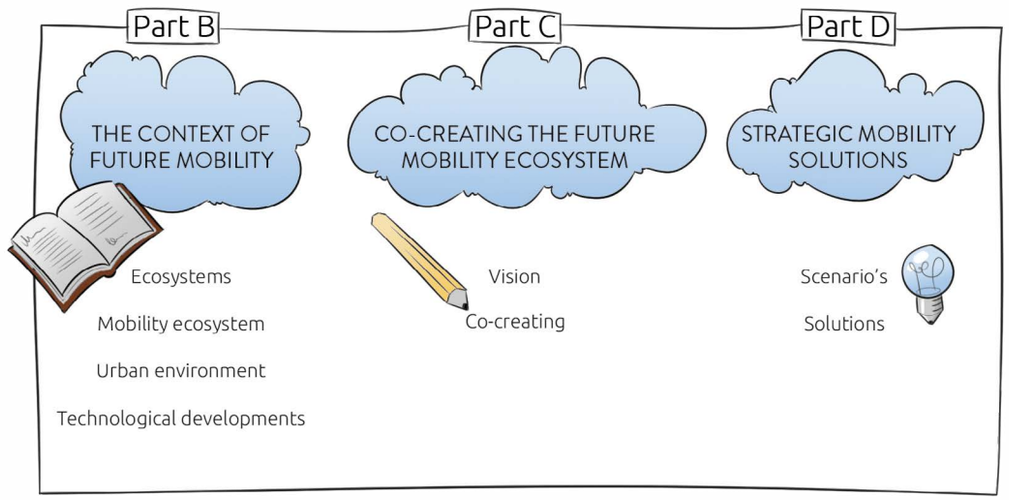


Figure 6. Design approach

THE CONTEXT OF FUTURE MOBILITY

With the motivation for this master thesis explained and the transition of Ford clarified, I elaborate on research I did of stakeholders of the mobility ecosystem in order to understand value flows. Second, I did research on urbanization, smart cities, urban design and urban mobility to distinguish variables in the ecosystem. Third, I investigated the technological innovations in the mobility industry and how this effect users. Finally, I interviewed experts in the field of innovative mobility solutions to understand what the possibilities could be in the future. All these insights are used to formulate a vision on future urban mobility.

1. STAKEHOLDERS OF AN ECOSYSTEM

An ecosystem consists of several subsystems such as the water, energy and the waste management system. Within this ecosystem there are multiple stakeholders that will be addressed in this chapter. First, a general map is described. Second details of the different stakeholders from the general map are given. This results in variables that will be used to describe the vision on future urban mobility.

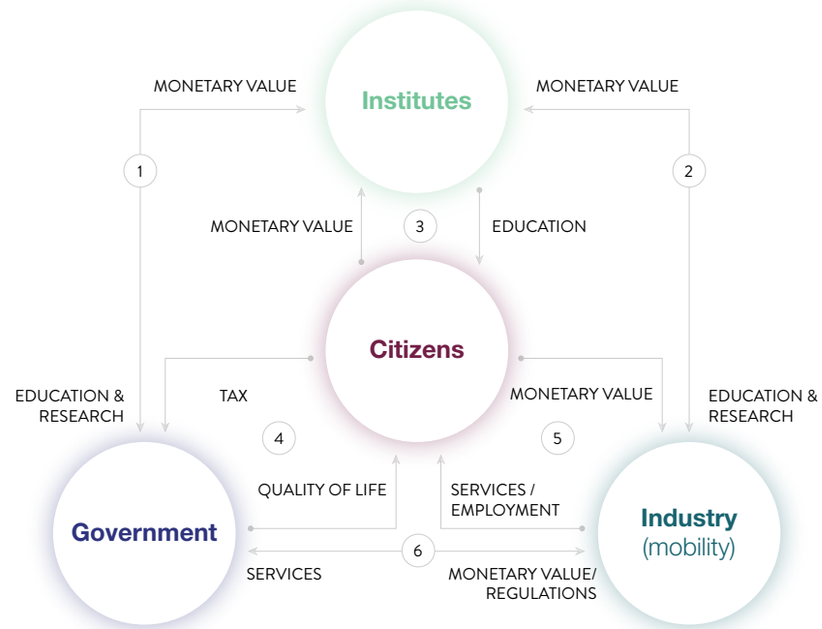


Figure 7. General stakeholder map

General map

A city is a complex system with multiple actors (stakeholders) preforming services (value) for some kind of value (e.g., money). If Ford wants to add new value to the system, it is important to realize which value currently flows through the system. This way, Ford could anticipate which actors will try to block or support the value and counter that movement (e.g., if Ford introduces shared autonomous vehicles, public transport companies can try to block this new service because they see a possible threat of a new competitor).

From literature, innovation in ecosystems often refers to the 'Triple Helix' model of Etzkowitz & Leydesdorff (2000) which describes the knowledge exchange between university-industry-government and their transforming relations. The change towards the knowledge economy gave people the tools to participate and influence the directions of innovation. Therefore, the 'Quadruple Helix' model emerged which allowed culture to become important for innovation in ecosystems (Carayannis & Campbell, 2009).

In Figure 7, I give an overview of the stakeholders of a city. This model is for innovation in ecosystems in general. With the knowledge economy (Brand & Rocchi, 2011) and social media platforms, citizens have more knowledge on changes in the ecosystem. Therefore, they can gravitate towards responsible innovation and equal value distribution. For this reason, citizens are placed in the middle as they are the main beneficiaries of, and contributors to the city.

To explain the value exchange:

1. The government subsidize institutes in order for the institutes to enable research on several emerging topics (e.g., health, artificial intelligence, mobility). Institutes provide knowledge and educate the government on possible implementations.

2. Institutes also provide knowledge and education for the industry. An example of such a value exchange is this master thesis where Ford collaborates with the TU Delft in order to do research on the implementation of new technologies.

3. Institutes exchange value with citizens as a platform for education. Scholars pay tuition in order to acquire knowledge and skills for their professional life.

4. Citizens pay taxes with every purchase they make, and with a percentage of their salary. The government on the other hand, guarantees a certain amount of life quality (differs per country). Quality of life could include road infrastructure, healthcare provision or a lower tuition fee for students.

5. Citizens also collaborate with industry as they use their products and services (e.g., grocery stores, cars or mobile phones) which they pay for. Also, the industry is an essential provider for employment for a large part of the population.

6. Finally, the government provides regulations for the industry in order to implement new products and services (e.g., autonomous vehicles). The government tries to only approve new products and services that increase the quality of life for its citizens. ►

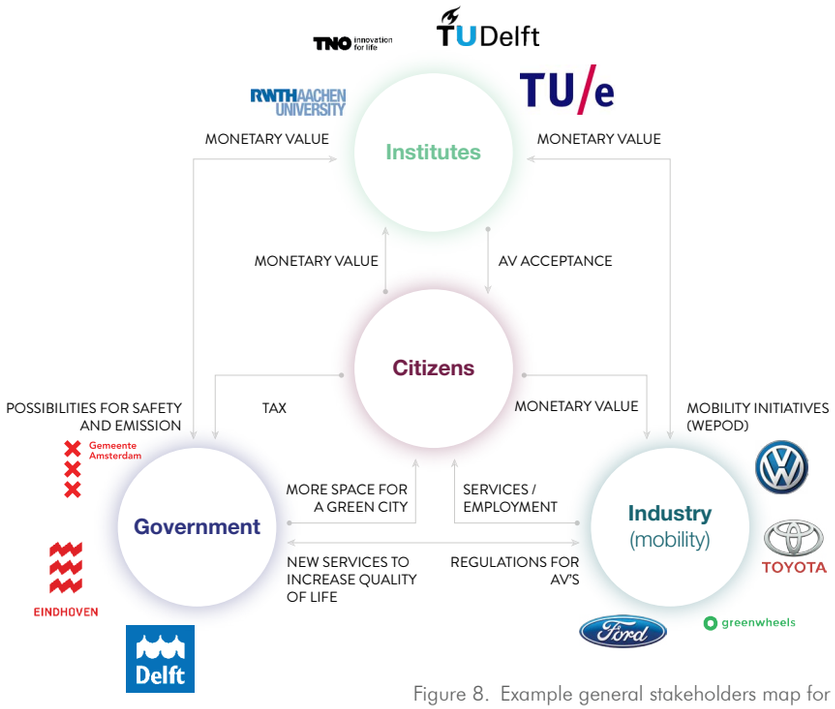


Figure 8. Example general stakeholders map for autonomous technology

Example of autonomous technology

To give a more concrete example of this system, an example of how new technologies are being implemented (for technology driven innovation) is stated in Figure 8.

a. **Institutes** do research in the opportunities of self-driving vehicles. With chips and processors achieving enough capacity to process big data and sensors from the vehicle, institutes raise awareness. Often industry also has research and innovation departments researching for new opportunities together with institutes.

b. **Industry** acts on this movement as new opportunities arise for products and services. Start-ups are quicker as they are more flexible, creating disruption in the market (e.g. Nest with the smart thermostat). Companies from other fields join the race to market as the new technology also opens up opportunities for them (e.g. Google and Uber with their autonomous vehicles).

c. **Governments** and municipalities want to create a habitable city for every stakeholder. They are responsible for creating opportunities for favourable innovations and block unsustainable innovation (for society as a whole).

d. **Citizens** are going to use the new services when they come to market. Important is the acceptance of the new technology, which often goes in small incremental steps.

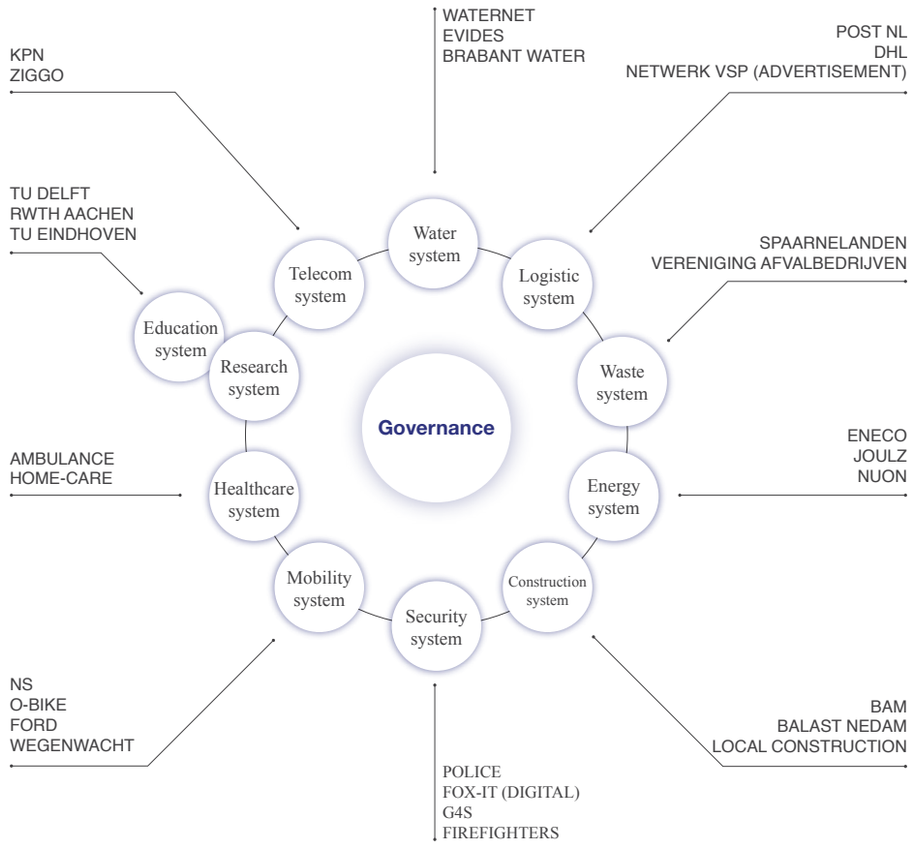


Figure 9. Government map with example companies

Governance

The example stated in the previous section is only one branch of the system (mobility). Howover, the government has multiple systems to regulate (see Figure 9). To make it more difficult, most of these systems are intertwined. A change in one system can disrupt another (e.g., autonomous technology from the mobility system can disrupt the logistics system) as they make use of each other's services. For this reason, it is important for Ford to know the value that other systems add to the city in order to anticipate what opportunities they can create with autonomous technology. ➤

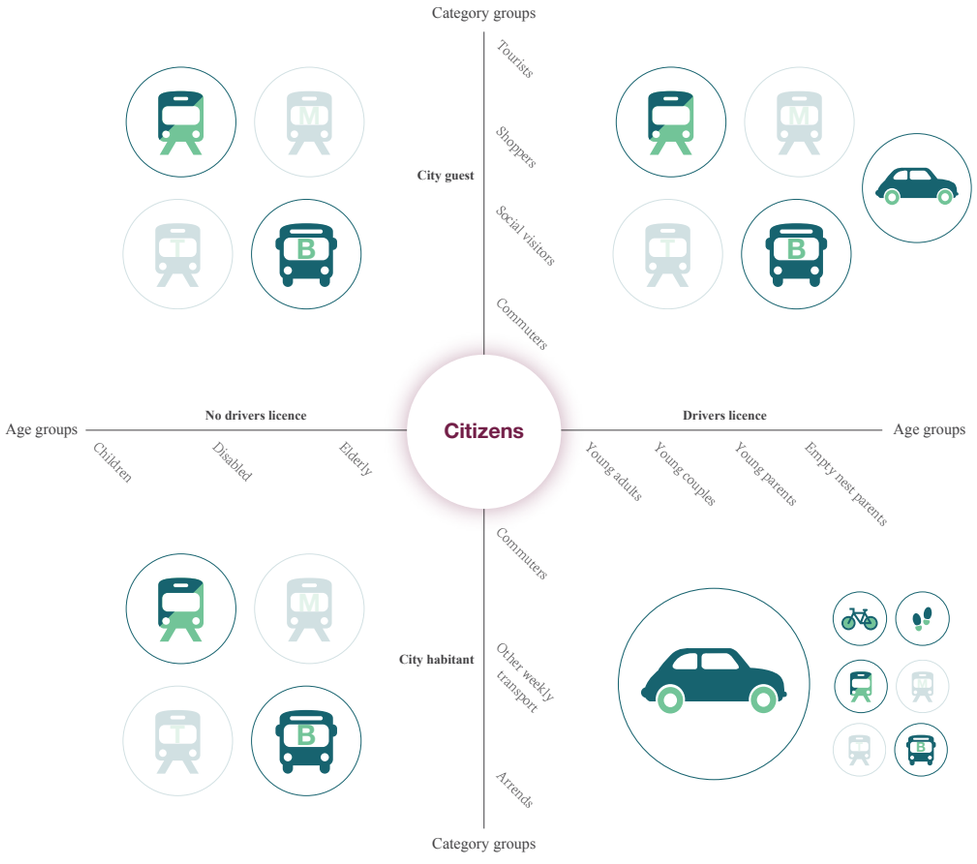


Figure 10. Citizens map

Citizens

Citizens are central in society as they (ideally) determine which decisions are made (in a democracy) on a national level (government) and on a local level (municipality). Therefore, the government or municipality will always decide in favour of society and its citizens. In order to know what citizens want, Ford needs to acquire knowledge about different groups which have different needs.

Figure 10, shows different target groups mapped for mobility needs. The horizontal axis shows the difference in target groups who own a driver's licence and the ones who have not. As autonomous technology creates opportunities for the citizens without a licence, this is an interesting group for Ford to further investigate.

The second axis shows the difference in citizens who currently live in a city, and those who enter as a guest. This also shows a difference in mobility modes by citizens with a licence. As the car is dominant at the moment, in Part B (Chapter: The urban environment) shows a movement towards more public transport, bicycles and pedestrians as space is very limited in cities. Therefore, Ford must specify journeys of target groups in order to tailor

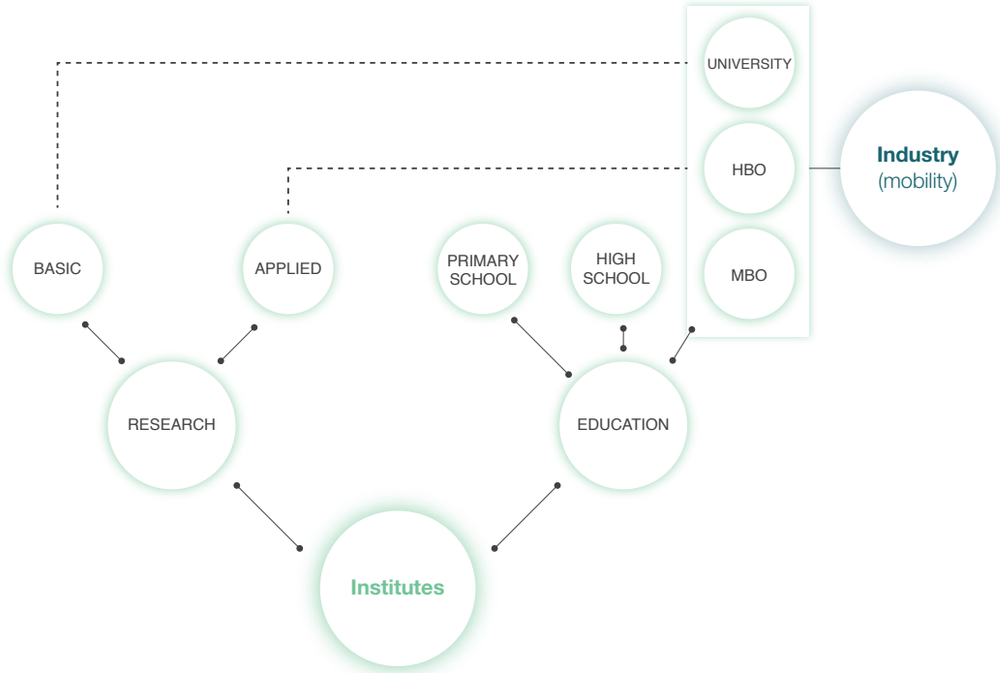


Figure 11. Institutes map

Institutes

Institutes provide a supporting role for the industry and the government as explained in the example. Their role is to provide sustainable responsible innovations and give advice for implementation. Ford should therefore work closely with companies such as TNO and universities as they provide knowledge and testing possibilities for new innovations.

An example of the value institutes bring is this graduation project. The knowledge created by this project is available and open for everyone to use. Also, it creates an opportunity for Ford to test possible fruitful directions for a relatively low investment. ➤

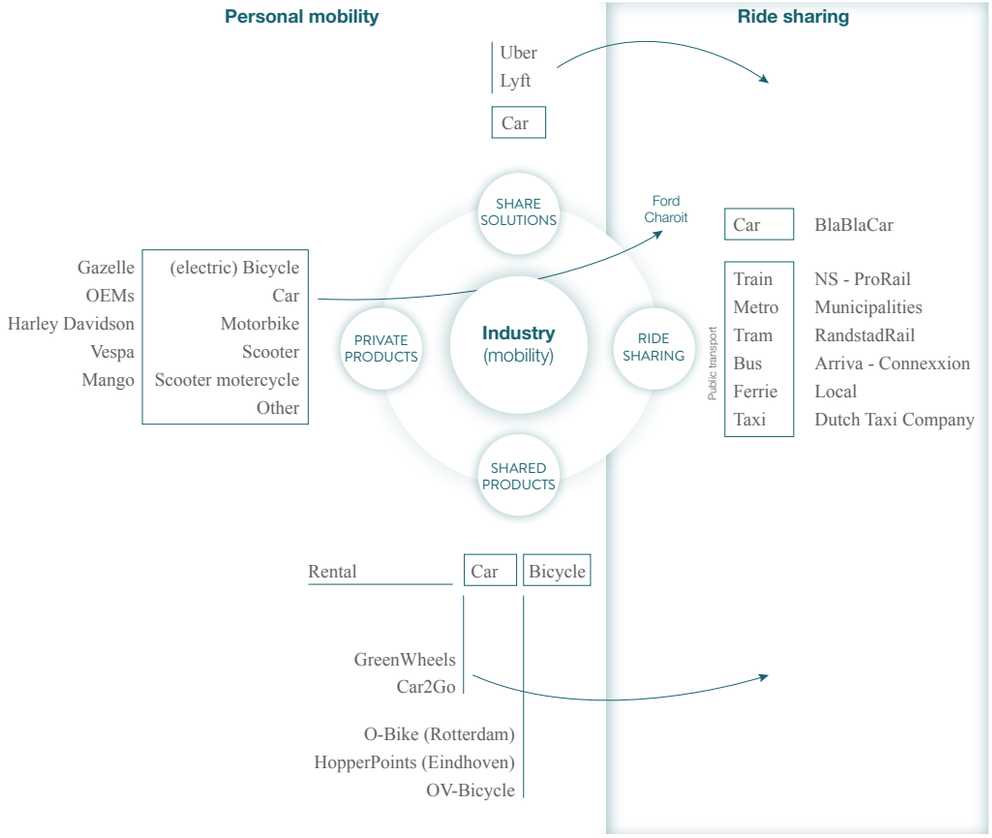


Figure 12. Industry map

mobility services accordingly.

Industry

As stated in the example of "Figure 8. Example general stakeholders map for autonomous technology" on page 32, the industry is an important part of our society, providing products and services in the city (see Figure 12). Industry difference from the government or from institutes as it has a commercial motive (to make profit). In the example mentioned, Ford works closely with institutes and participates with municipalities to look for the correct implementation of new technologies.

As industry as a whole is too large to include in one assignment, a scope is defined for this stakeholder: the mobility sector. This scope provides enough insight for Ford to get an overview of different actors.

1. *Some terminology:*
2. **Ride sharing**: people using the same vehicle;
   Personal mobility: people
3. using a vehicle for themselves (or with family and friends);
   Shared product: people
4. sharing a vehicle but only one at the time;
   Share solutions: new business
5. models for a more efficient use of available vehicles;
   Private product: a person

owning a vehicle for his/her use only.
A distinction is made between ride sharing (right part of Figure 12) and personal mobility companies. Shared mobility has a lot of potential and half of all new mobility start-ups are about shared mobility (Canales et al., 2017). Companies are seeing a shift towards shared mobility as cities have little space for individual mobility, they are heavily investing in ride sharing possibilities (arrows), for example the Volkswagen MOIA and Ford Chariot.

In case companies are going to shift towards ride sharing, they are going to compete with public transport. This can be dangerous as the government has invested a lot in public transport and would not want to see it become obsolete. Also, as space is limited, it is questionable whether it would be wise to pull people from a large vehicle (e.g. bus or train) towards more smaller vehicles? As Ford should innovate responsibly and focus on solving global and local issues, shared mobility is an important area. Ford should innovate in order to increase urban mobility and reduce congestions. Therefore, public transportation companies are included in order to see how Ford can complement their strategy towards improved mobility.

Conclusion

The stakeholder maps mentioned in this chapter provide the groundwork for iterations of the vision on future urban mobility. As the ecosystem of mobility has multiple stakeholders, it is important to acknowledge and involve them in the design process.

The stakeholder iterations on the vision should clarify which value stakeholders want to add to the system and how they see this changing in the future. This way, an overview can be made and the role for Ford can be defined. In the next chapter, I analyse the specifics of the mobility ecosystem and define variables that are influenced by changes in the mobility industry. ■

2. THE MOBILITY ECOSYSTEM

This chapter explains the definition of mobility and users of the mobility ecosystem. Also, I elaborate on current mobility modes and how the mobility sector is organized. This research gives an understanding of different variables which can change when new technologies arise in the mobility industry. These insights will be used in the vision of future urban mobility.

Mobility in general

Just like the structure of plumbing in a building, traffic flow is a connected system where individual actions can have an impact on the system as a whole (Huitema, 2014). Mobility is seen as one of the most important facilities to support the functioning of the urban area (Staricco, 2013) and is seen as one of the most promising topics in Smart Cities, as it could produce high benefits for the quality of life of almost all the city stakeholders (Benevolo, Dameri, & D'Auria, 2016).

From the literature analysis, I gather the most important Smart Mobility objectives (Frank, Kavage, & Litman, 2006): (1) reducing pollution; (2) reducing traffic congestion; (3) increasing people safety; (4) reducing noise pollution; (5) improving transfer speed; (6) reducing transfer costs. These six objectives can be divided across the new innovations in the mobility industry: electrification (objective 1, 4 & 6), digitization (2, 5 & 6), and autonomous technology (2, 3 & 6). The focus will be on the need for individuality: *"Substantial evidence indicates that there will be the need for more flexible, individual mobility. It is apparent that a single company will not be able to satisfy the needs of all customers, given the complexity of the urban mobility systems"* (Spickermann, Grienitz, & Von Der Gracht, 2014). Therefore, multiple stakeholders need to cooperate in order to provide the Smart Mobility objectives and solutions need to be tailored to specific customer needs.

Mobility in its core:

> ***The movement or transport of goods (e.g. people, cargo, services) from one location to another.***

- **Movement/ transport**: there are several modes of transport available today: by foot, bicycle, car (ownership or shared), scooter, tram, train, bus, metro and others (e.g. Segway or skateboard).
- **Goods**: the product that is in need of movement or transport: people, cargo (small or large) and services (e.g. nursing, city maintenance).
- **One location to another**: this can be any movement, for A to B. Different areas bring different challenges, therefore different mobility modes are available.

Users of the mobility infrastructure

The mobility ecosystem has multiple users that use the infrastructure. Three different users can be identified: (1) people, (2) goods & services and (3) construction (see Figure 13). ➤

Figure 13. Different mobility users

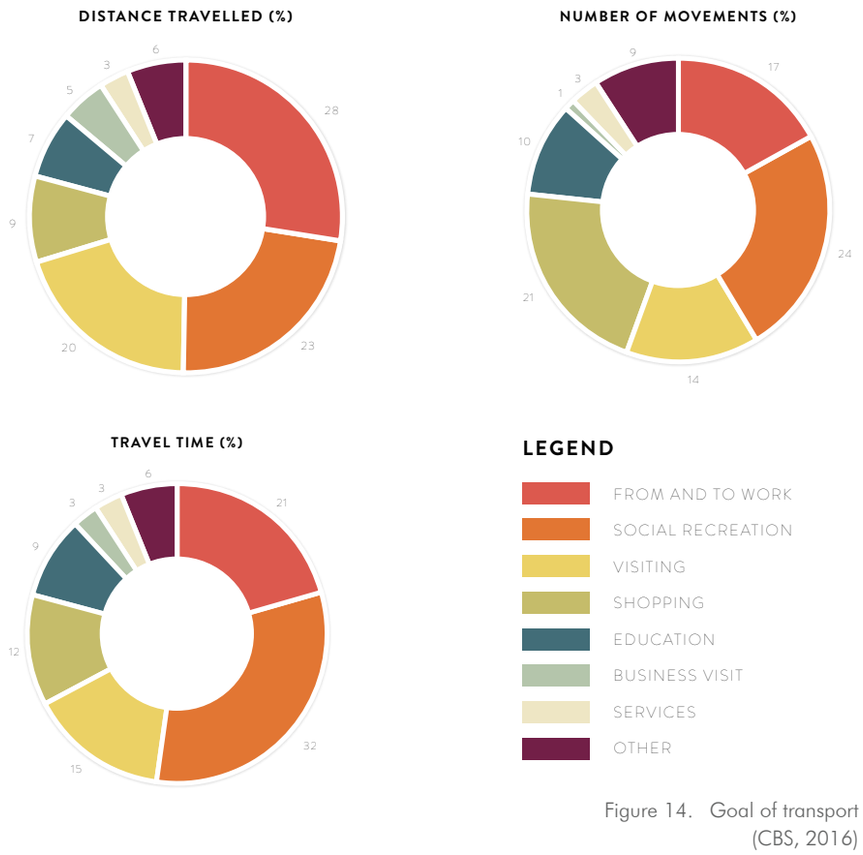


Figure 14. Goal of transport (CBS, 2016)

PEOPLE

People is one of the most familiar users of mobility. Most of us face this every day for several reasons (see Figure 14), sometimes with annoyance (traffic jams, public transport delays) but most of the time people do not notice how well-developed the infrastructure and the mobility options already are. For this assignment, I made the distinction between people with a driver's licence and people without. This choice is made because autonomous vehicles create opportunities for relative immobile people (who are not able to drive) to become more mobile.

In numbers, commuters for example (in average 10.000.000 persons) take on average 34 minutes a day and travel about 23 kilometres. 77 percent of the Dutch population use the car, 10 percent the train and 6 percent use the bike with peak moments (see Figure 15) between 7:00 - 8:00 and 17:00 – 18:00 hours (CBS, 2016). For more numbers in mobility in the Netherlands, see Appendix A: CBS numbers.

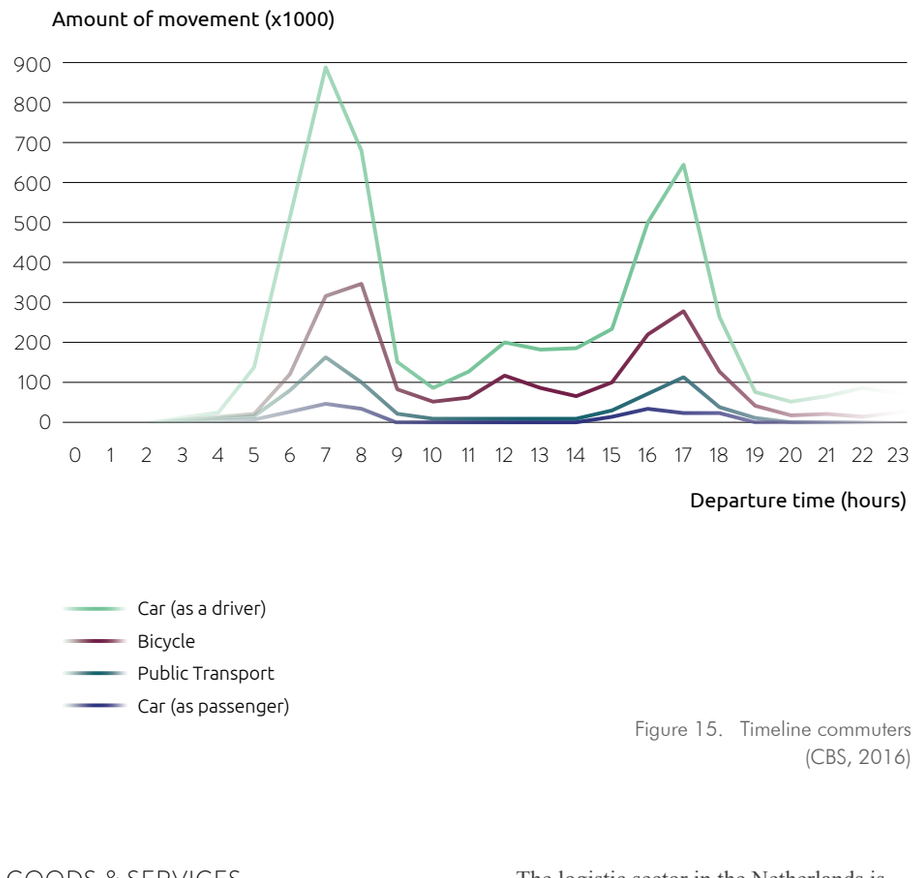


Figure 15. Timeline commuters (CBS, 2016)

GOODS & SERVICES

Transportation of goods and services is a more difficult topic because some possibilities are very specific. To give some examples, goods can be very small, such as a letter or a piece of clothing. On the other hand, goods can also be big, for example 50 casks of beer or new hospital beds. Services can be commercial or non-commercial. An example of a commercial service could be healthcare for elderly. For non-commercial services this could be an ambulance or fire truck.

The logistic sector in the Netherlands is relatively large, as the harbour in Rotterdam is the largest in Europe and Schiphol being a main hub. This is visible in employment opportunities, where the logistic sector is responsible for 490.000 jobs and 4,5 percent of gross domestic product.

In numbers, freight in the Netherlands is transported mostly through waterways (import 73 percent, export 80 percent). Road transportation mostly moved by truck (82 percent) and only a small percentage via rail transport (around 2 percent) although this is still a large freight of around 9 million ton import and 26 million ton export (CBS, 2016). ➤

CONSTRUCTION

Construction and maintenance also use our mobility infrastructure. A fact which is often forgotten or underestimated. These users often have different needs when it comes to infrastructure because it is also the place they work. Therefore, the environment needs to be accessible and safe. Maintenance is often responsible for road blocks, which can cause a lot of disturbance among other mobility users.

To conclude, I distinguish three different mobility users that use the urban infrastructure. The differences between the three variables are important when designing new mobility services as they all have their specific needs. For that reason, it is important that all three users are clearly displayed in the vision on future urban mobility.

Different mobility modes

When transporting people, good & services or construction, there are currently several modes available. The different mobility modes are shown in Figure 16 (an extensive analysis is available in Appendix B). Four main groups can be distinguished, (1) open, (2) commercial, (3) private and (4) public mobility.

In general, the car is still the most popular mode of transportation, with longest distances travelled, most travel time and most number of trips (see Figure 17). ➤

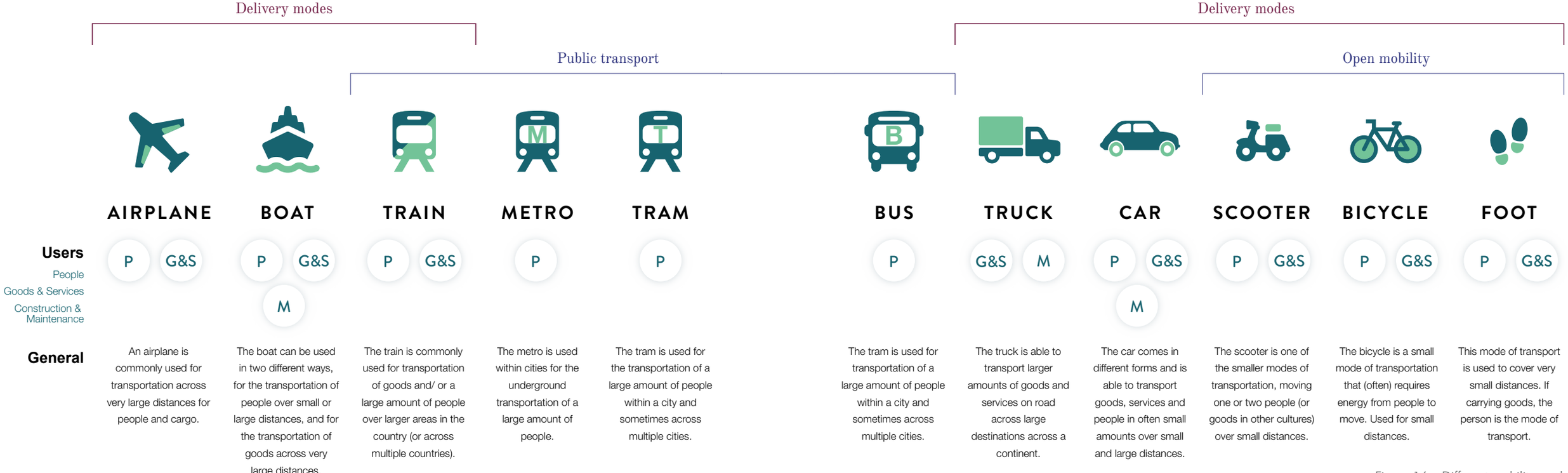


Figure 16. Different mobility modes

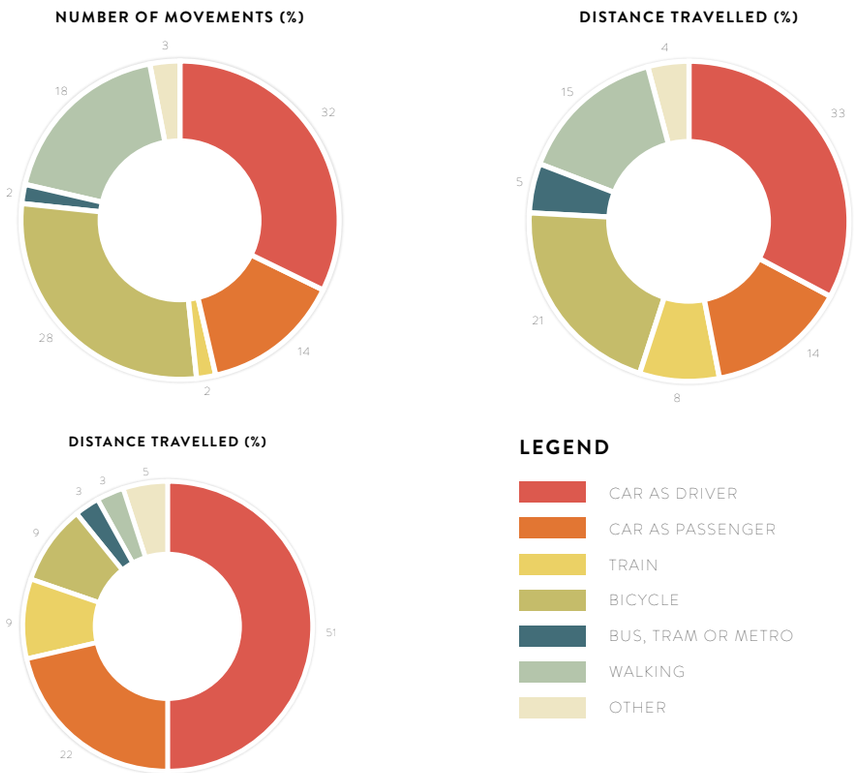


Figure 17. Mobility modes used in the Netherlands (CBS, 2016)

OPEN MOBILITY

These modes of mobility include all transportation done outside (e.g. walking, biking, scooter). As these modes become more dominant and popular in urban environments, this is an important part of mobility for this assignment. The Netherlands is the country with the highest rate of bikes per habitant (22 million bikes for 17 million people) and the Dutch bike on average 1.000 kilometres per person per year. Also, motors (650.000) and scooters (1.000.000) are a popular mode of transportation (CBS, 2016).

With urbanization, space is becoming more limited. Therefore, open modes of mobility are an important option for urban designers to account for as they take up less space.

Figure 18. Commercial mobility - Ford Tansit

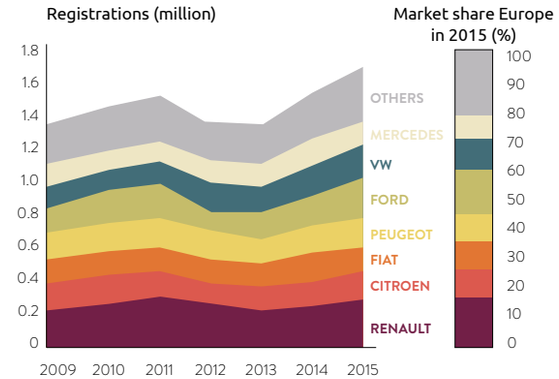


Figure 19. Light-commercial vehicles Europe (ICCT, 2017)

COMMERCIAL MOBILITY

This mode of mobility is often referred to as vehicles that are used for commercial purposes (e.g., delivery or maintenance). Common vehicles are transits or vehicles with a lot of storage room.

When looking at competition, Ford currently has a high market share in the light commercial vehicle segment (around 16 percent, see Figure 19) with the Ford Transit (see Figure 18) as the most popular vehicle (12,5 percent) in 2015 (ICCT, 2017).

PRIVATE MOBILITY

This mode of mobility is often referred to as car-ownership (lease or buy). It means that the vehicle is fully available for people transportation for one person (and possibly family or friends). On average, Dutch people travel around 11.000 km on a yearly basis, where around 73 percent commutes/ travels by car (CBS, 2016). This mode of transportation is very inefficient as most of the time the vehicle is not used to its full potential (parked 95 percent of the time (Barter, 2013) and often used by 1 person). ➤

Figure 20. Private mobility - Ford Fiesta

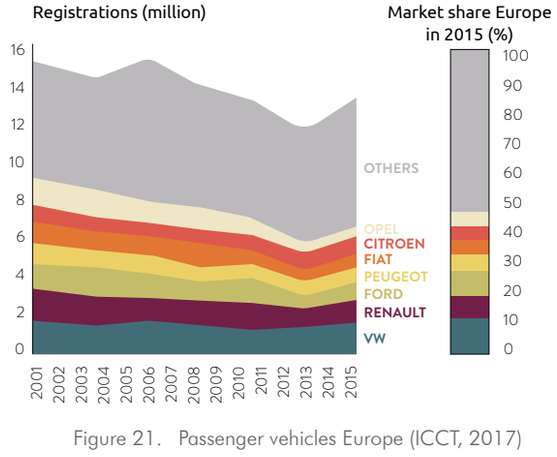


Figure 21. Passenger vehicles Europe (ICCT, 2017)

Ford currently stands in the top three of highest market share in private mobility (also mentioned as ‘passenger vehicles’). With their Ford Fiesta as second most popular vehicle (2,3 percent next to 3,7 percent Volkswagen Golf), Ford is definitely a big player in the automotive industry.

PUBLIC MOBILITY

Public transport is an umbrella term for all transport that is publicly available. Publicly available transportation means that that it is both shared and accessible for everyone. With other industries enabling themselves to offer Mobility as a Service, the definition of public transportation changes.

At this moment, public modes of transportation are overseen by the government, making sure that public transport stays available for everyone. With new innovations such as autonomous shared vehicles, considerations need to be made to make sure that mobility within cities increases instead of decreases.

New sharing vehicle initiatives need to be altered so they work together with public transport, complementing public transport where needed or replacing it in a responsible way.

Conclusion

Mobility is an essential part of our civilization. Currently, mobility modes and providers work independently from each other (product-centric firms). Only public mobility has a platform where multiple modes of transport come together. Creating an open source platform is essential for multiple parties to come together and participate towards achieving Mobility as a Service.

The mobility modes displayed in Figure 16, are a display of the current situation. With autonomous technology, a lot of those modes can be adapted or transformed. For this assignment, focus is on the transformation of the bus, truck and car as they are close to Ford’s current expertise and core business. Within these three modes, there is flexibility in usage. For example, a car can become a mode for public transport.

In the next chapter, I analyse different aspects of the urban environment and define different urban variables that are influenced by the transition of the mobility industry such as different city zones. ■

3. THE URBAN ENVIRONMENT

There are in general three focus points where automotive companies focus their innovation capacity for autonomous technology: (1) highways, (2) urban areas, and (3) rural areas. As (1) highways and (3) rural areas are a relatively closed environment with a (relatively) easy set of rules, (2) urban areas face much greater challenges but also much greater reward. First, I will explain urban development research and the definition of a Smart Cities. Second, I will go into detail on urban design and urban mobility.

"The 19th century was a century of empires, the 20th century was a century of nation states. The 21st century will be a century of cities." – Wellington E. Webb, former Mayor of Denver, Colorado (Jubi, H Scrimger, 2000)

Urban development: towards a smart(er) city

Cities are developing and adapting towards a smarter environment. I did research into urbanization and the development of smart cities (how can technology improve the quality of life in urban areas).

The world population is growing at a rapid pace. Towns and cities are accommodating half of the world's population thereby creating tremendous pressure on every aspect of urban living (Perera, Zaslavasky, Christen, & Georgakopoulos, 2014). Globally, the number of people living in cities of one million or more will grow from about half a billion in 1975 to almost two billion in 2025 (World Economic Forum, 2009). A broad range of urban resources and services, including road and transportation system capacity, electrical power, effluent emission, fresh water, public health, and public safety, are subject to increasing pressure (Harrison et al., 2010). To seize opportunities and build sustainable prosperity, cities need to become "smarter" (Dirks & Keeling, 2009).

Development of cities

The concept of the Smart City emerged during the last decade as a fusion of ideas about how information and communication technologies might improve the functioning of cities, enhancing their efficiency, improving their competitiveness, and providing new ways in which problems of poverty, social deprivation, and poor environment might be addressed (Harrison et al., 2010). Urban structure and transport system developments are closely connected, and it is impossible to abstract the vision of the cities of tomorrow from that of the future configuration of their transport systems (Alessandrini, Campagna, Site, Filippi, & Persia, 2015).

What are smart cities?

Research has been devoted to the definition of smart cities. Key components are stated in Table 1.

In my perception, I would summarize a smart city as *an intelligent city that is able to adapt new technologies to improve the quality of life for its citizens. A city does so by collaborating with relevant stakeholders to ensure the optimization of stakeholder collaboration and reducing the environmental footprint.* With this abstract analysis done on urban development, I now turn towards the design of urban areas and how mobility infrastructure has developed. ➤

Table 1. Component of smart cities

Components	Literature	Explanation
Better quality of life	Batty et al., 2012; Benevolo, Dameri, & D'Auria, 2016; Caragliu, Bo, & Nijkamp, 2015; Chourabi et al., 2011	The smart city offers a level of certainty, freedom and security for its citizens, industry and institutes in order tocreate a desirable environment.
The use of technology	Batty et al., 2012; Huitema, 2014; Schaffers et al., 2011; Chaves, A.P. Gerosa, 2017	A smart city is capable of using smart technologies for the improvement of the quality of life.
Reducing environmental impact	Benevolo et al., 2016; Chourabi et al., 2011; Dirks & Keeling, 2009	One way to use smart technologies is to reduce the impact on the environment, therefore improving quality of life. This is essential for the stability of the city.
Collaboration between stakeholders	Batty et al., 2012; Benevolo et al., 2016; Caragliu et al., 2015; Chourabi et al., 2011; Fontana, 2011	In order to implement technologies, a smart city needs to collaborate with others (e.g., Telecom providers or housing cooperations) in order to guarantee successful implementations.

The design of cities

There is great diversity in the construction of cities before cars became popular and accessible for mass population. I distinguish three different zones: (1) Downtown; (2) Pre-war and; (3) Suburbs.
In downtown areas (often designed and constructed before cars), houses are build close to each other with small roads in between for pedestrians and possible cyclists (see Figure 22). Urban landscape architects call this the A zone (build around 1000-1850). Outside the A zone, the pre-war area is defined as zone B (build 1850 – 1940). Here, indications are visible of the influences of cars in the design of the city. Although there was enough room in the past, today, this area causes a lot of disturbance for mobility options. Last, zone C (build 1940 – present) are the suburbs where neighbourhoods are designed to handle the traffic or designed to keep certain traffic outside of living areas.

These three zones have very different mobility demands and need to be taken into consideration when developing mobility solutions. A workshop on Dutch urban mobility solutions with Christiaan Kwantus (Strategic urban planner) and Marco Aarsen (Urban architect) gave the following insights:

1. Municipalities are facing more difficult mobility challenges in urban areas through urbanization and current infrastructure.
2. Municipalities' biggest concerns are space and emission.
3. The bicycle is becoming a popular focus point for urban area mobility as they take up less space than cars.
4. 'The best cycle plan is a car network plan', meaning that you cannot design for one transport option without considering the other.

Still, these urban zones are very different across Dutch cities. The second world war causes major destruction of cities which had to be reconstructed. For that reason, cities such as Eindhoven and Rotterdam have a different infrastructure and lost most of its earlier zone A characteristics as is still present in Delft or Amsterdam. Cities such as Rotterdam and Eindhoven have a better car infrastructure in place than Amsterdam or Delft, making it easier for autonomous technology to be tested.

However, to say that a city exists of three parts is a little blunt. As cities become bigger and bigger, sub-centers evolve within a municipality. In Figure 23, an example is given of sub-centers in the city of Eindhoven. These sub-centers are not attractive for tourists but created for daily or weekly shopping by residents from local neighborhoods. Public transport is focussed to get people from different sub-centers to the actual city centre and back. Keep in mind that there is often only one historic downtown centre in a city, but there can be multiple downtown sub-centers which are not historic (therefore, less touristic). ➤

Figure 22. City zones (Kwantes & Aarsen, 2017)

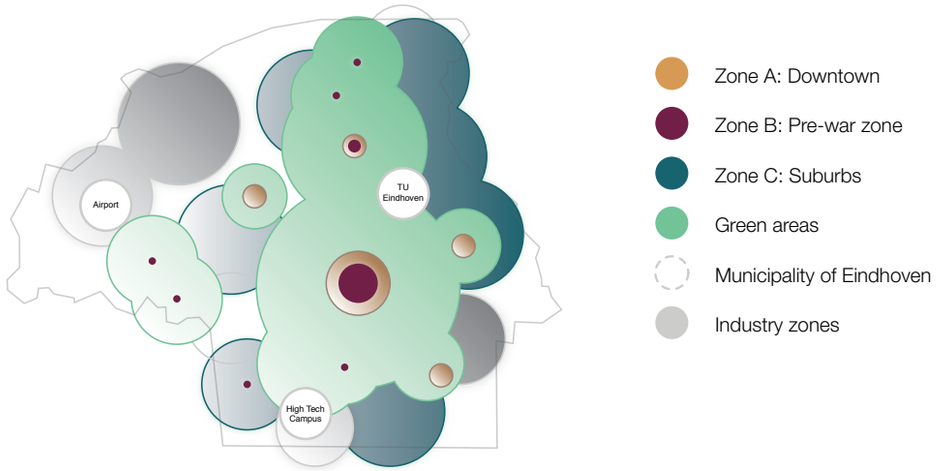


Figure 23. Sub-centers in a municipality

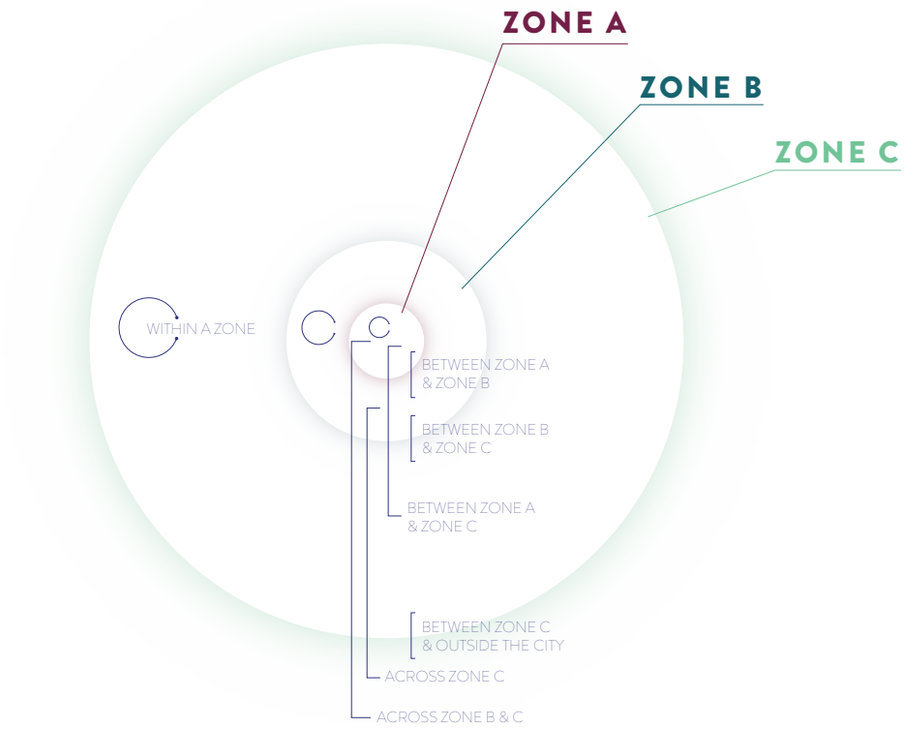


Figure 24. Schematic overview urban environment

Mobility options in cities

Within a city with different zones, there are also different mobility needs. In Figure 24, the different zones are generalized, and different mobility needs are mapped. For a complete overview of mobility options see Appendix C: Mobility options.
This generalized overview can be used for every city (not considering sub-centers). However, it is important to mention that every city has its own infrastructure. Therefore, mobility solutions should be designed accordingly.

In general, three different needs can be characterized:

- **Within a zone**. This kind of transportation is relatively inefficient (especially in zone C) as all public transport always brings you through the main hub (e.g. central station). This causes a lot of pressure in that hub.
- **Between two zones**. This kind of transportation often includes zone B. Zone B is where most of the city congestions happen as there is space for cars, but very little.
- **Across zones**. This kind of transportation often involves travelling from one city to another. With public transport, the train is the most popular option. It is important for transportation across zones to see what the actual endpoint of the journey is as this is often not zone A (which is a visiting point). This is also not efficient.

Cities can be mapped in different zones (downtown, pre-war, and suburbs). Multiple zones can exist in one municipality.
Insight from this analysis state that space is a challenge when designing urban infrastructure. A possible solution is a bicycle friendly infrastructure which could solve parts of the challenge.

In order for Ford to innovate responsible and act on local and global issues, urban space is an important focus point. Jim Hackett (CEO Ford) is taking the right steps towards this movement as he says Ford is going to *"give the streets back to the community"*. Thereby, he acknowledges that cars ownership is not a sustainable mode of transportation in urban areas.

Cities in the Netherlands

For this assignment, a focus needs to be chosen in what kind of city Ford should focus to introduce and test their new mobility solutions.

In general, the Netherlands is the most promising county for implementing Autonomous Vehicle's (AVs). The Netherlands provides an AV readiness model for other countries to follow, with excellent road infrastructure, a highly supportive government and enthusiastic adoption of electric vehicles (KPMG, 2018). ➤

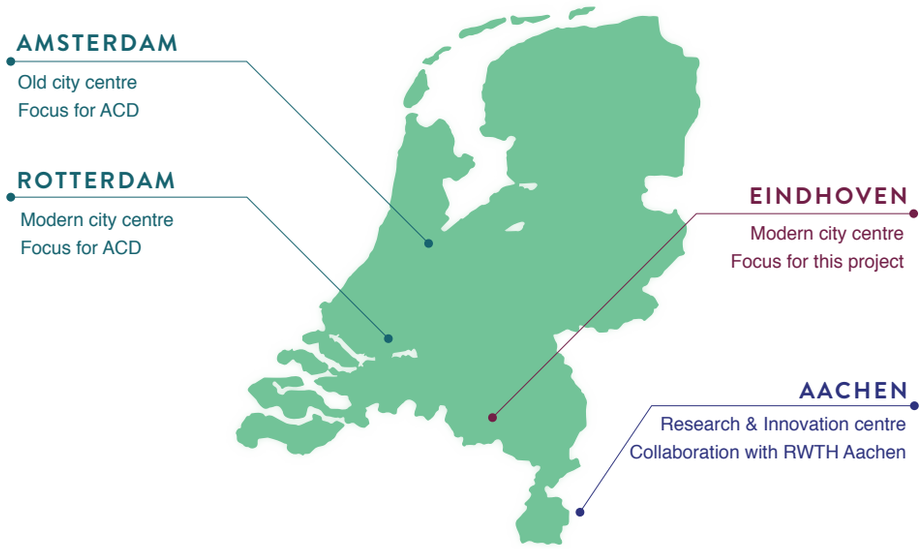


Figure 25. Overview landscape

The Research and Innovation facility of Ford in Europe is in Aachen (see Figure 25). As there are multiple options for Ford to focus their development of AV's. Different factors I mention are: (1) size of city, (2) city infrastructure, and (3) willingness of stakeholders. Currently, Rotterdam and Amsterdam are already investigated by another design courses (e.g., Advanced Concept Design). Although this is a different master within IDE, context research can still be brought into other projects.

CITY SIZE

The size of the city is an important factor as it determines the scale (and commitment) for implementation. Larger cities (more than 250.000 inhabitants, see Figure 26) facilitate more people which could benefit from the acceptance and use of new technologies. However, with radical new technologies, it is hard to research what users will use and would prefer in an AV. Therefore, quick iterative testing is preferred, making (relatively) smaller cities more attractive.

RANK	NAME	POPULATION
1	AMSTERDAM	848,861
2	ROTTERDAM	638,221
3	THE HAGUE	524,305
4	UTRECHT	343,084
5	EINDHOVEN	226,879
6	TILBURG	213,840
7	GRONINGEN	201,535

Figure 26. City population (CBS, 2017)

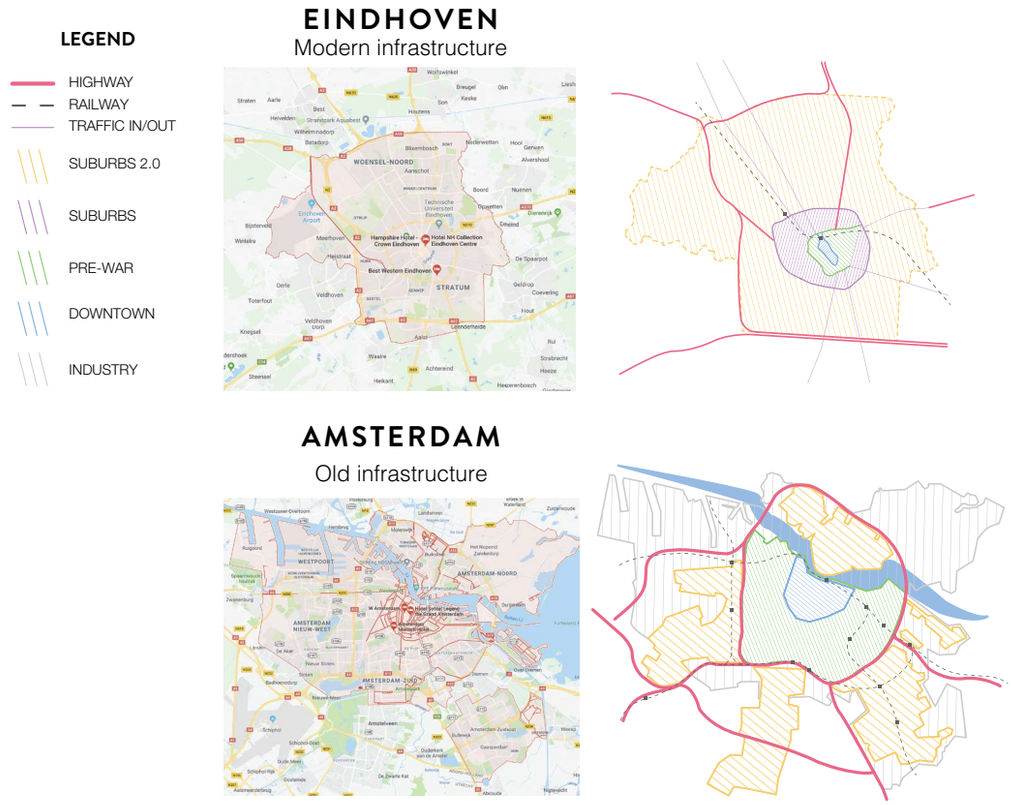


Figure 27. Infrastructure between cities

CITY INFRASTRUCTURE

The Netherlands has two different types of city infrastructure: (1) the part that stayed intact in the second world war and (2) the part that was bombed. After the second world war, the popularity of cars increased, and city infrastructure could be designed accordingly. Eindhoven and Rotterdam have therefore a car friendlier infrastructure than, for example, Amsterdam, The Hague or Utrecht. For quick iterative testing, a car friendly infrastructure is recommended.

As visible in Figure 27, it is clear that Eindhoven has more options for entering, leaving and moving across the city than a city such as Amsterdam. Although Amsterdam is a whole other level of city (number of inhabitants), it is still clearly visible that entering the green area (zone B: Pre-war) is more difficult than in a city such as Eindhoven.

What is special in Eindhoven, as it has a car-friendly infrastructure, it does not offer a metro or tram network for people ➤

transportation in the city. Therefore, Eindhoven has placed an abundance in parking spaces on the inner ring (see Figure 28), so people can easily move themselves by car. Implementing AVs in the city centre can therefore be a problem. If people do not have any problems parking their car in the centre, the need for an shared vehicle which drives them to the centre and drives back itself, it not needed. Also, if AVs were implemented, the municipality could see a drastic decrease of parking earnings. Although the municipality would have more space to give back to its people (e.g., for housing, green or social environments), they will need to budget these changes.

WILLINGNESS OF STAKEHOLDERS

To see where Ford is able to test and introduce their autonomous technology, willingness to participate and innovate is crucial. The technical university of Wien ranks cities through a model which provides an integrative approach to profile and benchmark European medium-sized cities and is used for urban innovations (Giffinger, Kramer, Haindlmaier, & Strohmayer, 2014).

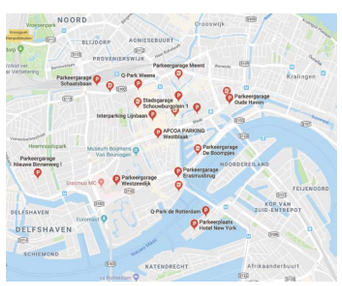
Difference in city size is taking into account. Eindhoven scores best on the topic of smart mobility in Europe (see Figure 29, Figure 30).

This research shows to willingness of stakeholders (e.g. the municipality) to develop new mobility solutions. With large multinationals such as Philips and ASML, Eindhoven is seen as the Silicon Valley of the Netherland (Libbenga, 2015) as it currently facilitates hundreds of start-ups. Also, their high-tech campus connects to the automotive campus in Helmond (nearby city) where already a lot of research is being done on automotive technology.

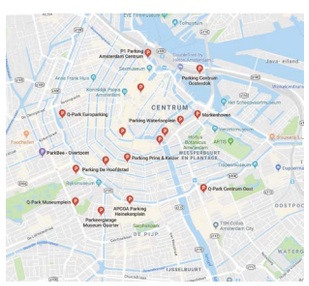
CONCLUSION

Ford has several opportunities to develop and test their autonomous technology. The most important factor is to test quick with multiple iterations. Eindhoven shows positive outcomes, on all three factors (size, infrastructure, stakeholder willingness), therefore, Eindhoven is chosen as the context for this assignment.

Rotterdam



Amsterdam



Eindhoven

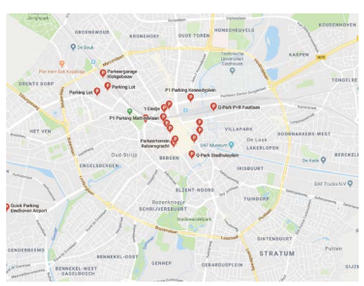


Figure 28. Parking spaces between cities

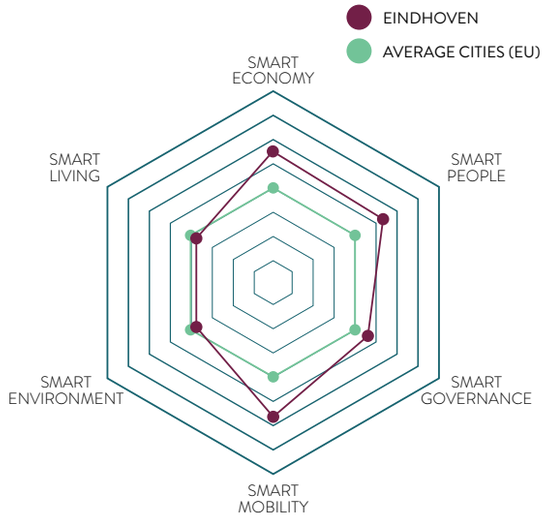


Figure 29. Overview of ranking for Eindhoven (Giffinger et al., 2014)

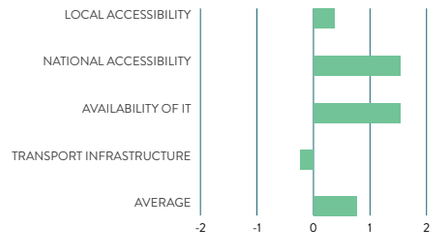


Figure 30. Comparing Eindhoven to other cities (Giffinger et al., 2014)

A closer look into Eindhoven

Ford has several options if they want to enter the Dutch market with autonomous technology. As said in the previous chapter, it will be easier to implement AVs in cities where there is a better car infrastructure.

In Figure 31 on page 58, it is visible that just a very small part of the city can be mapped in Zone B (pre-war zone), this is again because of the second world war. Therefore, a lot of infrastructure is rebuilt and made more accessible for cars.

This car friendly infrastructure is clearly visible in Figure 32 on page 59, where multiple rings are placed around the zones which makes it easy for cars to get in the city, out of the city, and around the city. What is special in Eindhoven is that it has three rings to get around the city, creating an attractive environment for the car as it does not have to cross the busy centre (and therefore also an attractive environment for other travellers and visitors).

Eindhoven is not only far in creating smart mobility solutions (as stated in the research of Giffinger, Kramer, Haindlmaier, & Strohmayer, 2014), but also in new infrastructure solutions for traffic flow. As can be seen in Figure 33 on page 59, this road has given the priority to bicycles instead of cars (as you can see at the sign besides the road). This makes cars '*guest*' and bicycles the main travellers of the road. This bicycle friendly mind-set, is adopted by other cities. In Delft for example, the municipality placed a bicycle dominant road from the central station all the way to their university. ➤

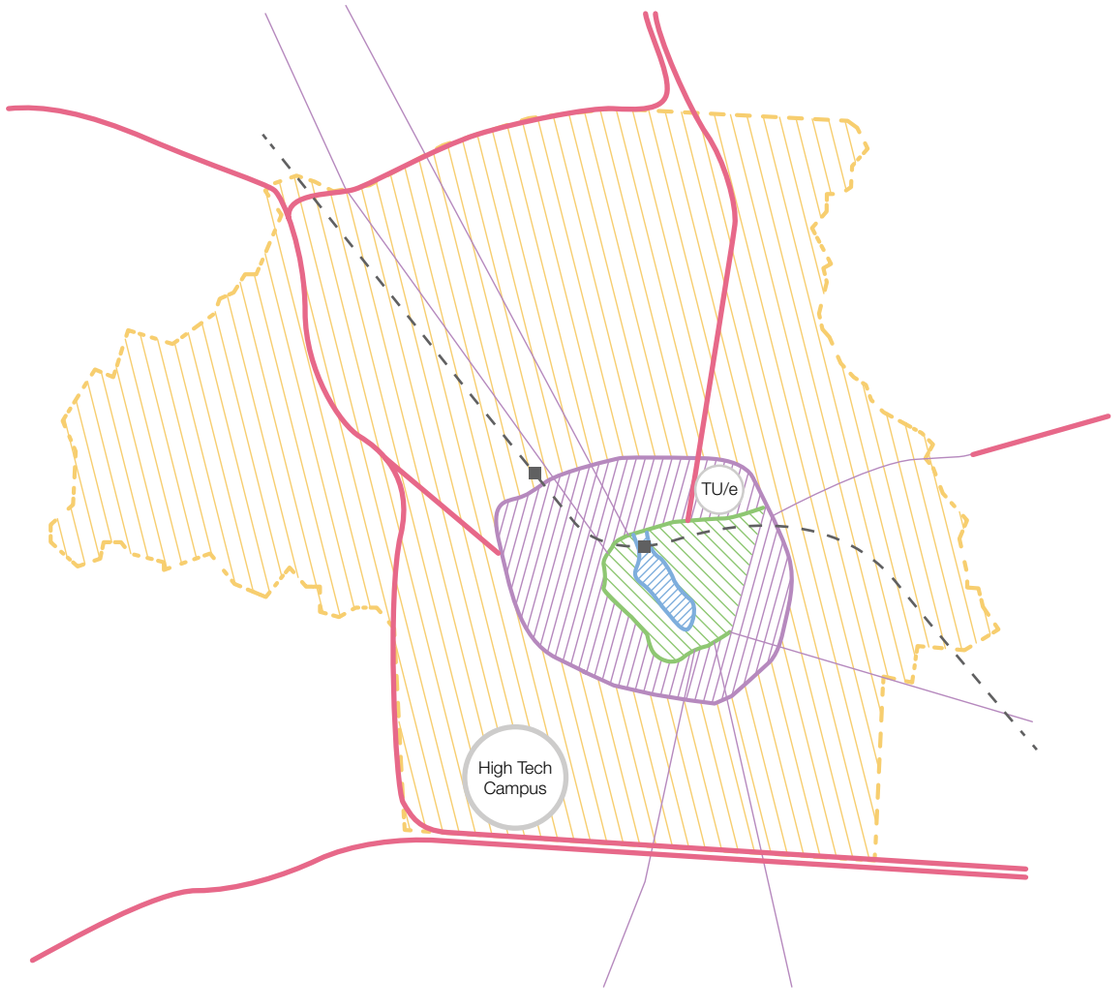


Figure 31. Different city zones in Eindhoven

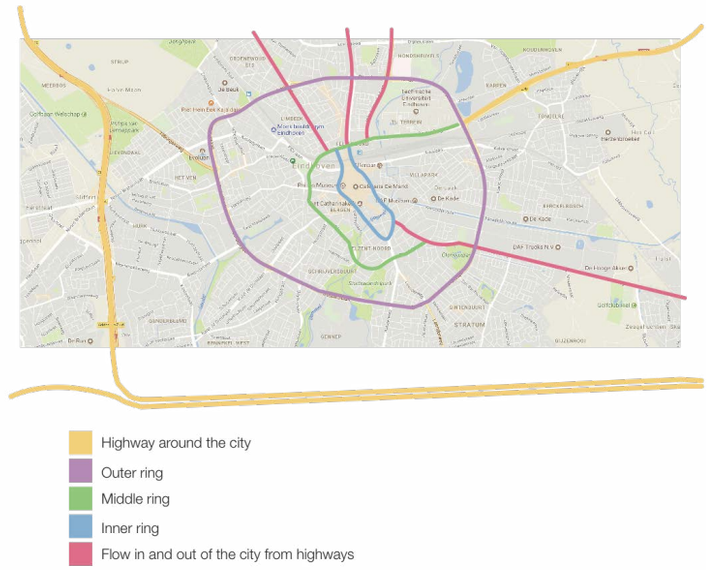


Figure 32. Different infrastructure

Conclusion

Ford needs to consider several factors when introducing AVs in urban areas:

• There are different transportation needs and for the different city zones (A, B, and C).

• How far is the city in its regulations towards the acceptation of AVs?

For the municipality of Eindhoven, this will be taken in consideration when designing a strategy for Ford. Eindhoven is a valuable starting point as they are ahead on regulations and initiatives towards AVs together with Helmond. Also, the city infrastructure creates a great opportunity for the first tests on autonomous vehicles. There are little busy and overcrowded areas where vehicles, cyclist and pedestrians meet uncontrolled.

With the ecosystem, stakeholders and the urban environment analysed, I will elaborate on technological development in the automotive industry and how this could influence urban mobility. ■

Figure 33. Example of a bicycle lane with priority

4. TECHNOLOGICAL DEVELOPMENTS

This chapter describes technological changes and implications in the automotive industry. First, I will explain three main technological developments. Second, how Ford sees these developments affect mobility and third, how users could experience these changes.

Technological developments in the automotive industry

There are three main technological developments happening in the automotive industry that transform the way business is done and how people use mobility: (1) electrification; (2) digitization; (3) autonomous technology.

ELECTRIFICATION

Electric technology enables the mobility industry the change from fossil fuelled vehicles towards vehicles which run on renewable energy sources (e.g., biogas, hydrogen, solar power). True sustainable mobility is only achieved when the source of the electricity is generated sustainable.

The transition towards electric vehicles creates several opportunities and challenges for the automotive industry. An opportunity for car manufacturers is having more freedom in designing the shape of the vehicle as there are less moving components and less need for oxygen supply and cooling mechanisms. If more and more electric vehicles come to the market, governments and municipalities can start pushing fossil fuelled cars out of cities which enhances the quality of life in urban areas. On the other hand, creating a new network of charging stations is a big investment on a large skill, it needs to be implemented before electric vehicles are accepted by the larger part of the population.

DIGITIZATION

Jim Hackett (CEO Ford) said in an interview with Fast Company that dumb cars are of the past (Safian, 2017). When people are introduced with smart(er) products, they never go back to dumb(er) products. Smart vehicles can have a combination of several features that enable the user to more comfort and/or efficiency. An example of smart technology is that Google can advise you to take an alternative route to avoid traffic jams.

Digital technologies are an umbrella for several developments: (1) analytic technologies and applications; (2) mobile technologies; (3) cloud technologies; and (4) social media technologies and applications.

1. The processing and analysing of big data which can progress to Artificial Intelligence (A.I.). This could benefit the automotive industry in recognizing new information and self-learn from this (deep-learning).
2. Everyone nowadays has some form of connected device which is connected to the internet and enables a lot of data that can be used for mobility services. Smartphones and other mobile devices will therefore become an omniscient companion and enabler of multimodal city travel (Spickermann et al., 2014).
3. Cloud technologies enable digital sharing capabilities over the internet. This enables parties to combine knowledge and applications for services.
4. Social media is a tool where people can connect to peers or other parties. Companies who are smart enough to adapt can benefit from this technology and find new channels to connect to their users. ►

For example, real time traffic information is connected to Google (3), which is connected to your phone (2), and is also connected to your location and your infotainment system of your car. Google can support you in finding the fastest connection to your destination (1). This connection can be wired or wireless (e.g. internet, Bluetooth, or GPS) and is closely in contact with our personal mobile devices.

Smart also means that it can know, sense, and track analogue changes. Sensors are more and more implemented in devices to deliver more customized experiences. Examples are sensors in the refrigerator that senses when the milk is almost finished, or a car that senses when the backseat is occupied and therefore will not move until the seatbelt is locked.

AUTONOMOUS TECHNOLOGY

Autonomous driving is the technology that enables vehicles to move itself without the control or intervention of a person. There are different levels of autonomy a vehicle can have, from level 0 automation, to level 5 automation (exact explanation in Figure 34). Several car manufacturers have communicated that they will enter the market with level 4 automated vehicles around 2021. Ford promises a level 4 automated vehicle in 2021, which can manage all aspects of dynamic driving tasks, also when to driver is not able to intervene.

Autonomous technology can bring great advantages (e.g., safety, sustainability, less congestion, less parking). As this technology is still maturing, there are also several challenges that need to be overcome (e.g.,

Level	Name	Narrative definition	Execution of steering and acceleration/ deceleration	Monitoring of driving environment	Fallback performance of *dynamic driving task*	System capability (*driving modes*)	BASt level	NHTSA level
***Human driver* monitors the driving environment**								
0	**No Automation**	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a	Driver only	0
1	**Driver Assistance**	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes	Assisted	1
2	**Partial Automation**	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes	Partially automated	2
***Automated driving system* ("system") monitors the driving environment**								
3	**Conditional Automation**	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task* with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes	Highly automated	3
4	**High Automation**	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes	Fully automated	3/4
5	**Full Automation**	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**	.	

Figure 34. Different levels of automated driving (cyberlaw.stanford.edu/loda)

privacy of data, liability, dilemma situations hacking). For a full detailed analysis on the advantages and challenges, see Appendix D: Autonomous technology. Important is the possible positive impact that this technology can have on the quality of life in urban environments. As the technology is maturing extremely rapid, mobility providers should start designing for this technology to add value to the ecosystem.

Several interesting conclusions can be drawn from these three technologies and the way they are currently implemented. One hand, there are arguments that say these developments are a technological push (the technology comes available, so let us diverge and see what kind of opportunities derive from it). On the other hand, global warming is becoming more recognized and people feel responsible for creating a healthier world, therefore, pulling towards change (market pull).

To give some background, technology push comes from inside-out (Phaal, Simonse, & Ouden, 2008), and is perceived as divergent (looking for opportunities for implementation), asking the question: how can we use this (new) technology? Market pull on the other hand, is an outside-in approach where industry aims to develop a customer defined product (Phaal, Farrukh, & Probert, 2004).

In my view, electrification is a consequence of societal pull as it is a customer defined product, pulling the automotive industry towards a healthier world. The technology of digitization and autonomous vehicles on the other hand, is more technology pushed, therefore also this assignment: *how can we implement autonomous technology so that it improves urban mobility (divergent).*

Concluding on this topic, the three technologies that are disrupting the automotive market cannot be seperated from each other as they can offer more value when combined. Also, it is interesting to further investigate the consequences of autonomous technology as Ford can diverge into multiple possibilities with this technology. ➤

Figure 35. Vision of Ford: The 'City of Tomorrow' (www.corporate.ford.com)

Vision of Ford

With Hackett in control, Ford introduced a new vision that would fit their survival in the automotive business. Ford calls it the 'City of Tomorrow' rededicating itself towards creating mobility solutions for everyone or, *democratizing mobility*. In this 'City of Tomorrow', Ford understands emerging problems such as rising gridlock, pollution and ineffective mass transit. Near-term mobility advancements (e.g., autonomous, electric and smart vehicles), could create a more cohesive transportation ecosystem.

"We want to give streets back to the communities" – Jim Hackett (CES, 2018)

Ford envisions that this system is holistic, organic and inter-connected, combining different mobility solutions together with a transportation operating system. Instead of roads that are filled with traffic jams, more priority to (electric) biking is created and parking lots are redesigned for social purposes. More accessible public transport is created and there is more space for green areas.

Not only vehicles, but also the road has its transportation operating system, allowing for more traffic flow and safety among pedestrians and cyclists. In the 'City of Tomorrow', life is healthier, easier to get around, safer and more productive through the removal of accidents, emissions and congestions, creating universal mobility access.

Figure 35 & Figure 36 give a quick impression into the 'City of Tomorrow'. What is clear is that urban space is very valuable and preserved. Ford sees that autonomous technology could decrease the space used by cars in the city, therefore, eliminating parking garages and parking lanes for social and green environments. Also, Ford does not speak of 'cars', 'bikes', or other specific modes of transportation, but speak of mobility. Therefore, they are broadening their view towards a city that is not dominated by cars. Lastly, in the figures is a clear shift towards room for bicycles and pedestrians as this is a healthier and space efficient mode of transportation within the city.

From this vision, it becomes clear that Ford wants to expand their business from a car manufacturer, towards offering universal mobility access. This is a big change for a 100+ year old global company as the company (around 200.000 employees in 2016, www.corporate.ford.com) is built around mass-producing cars. Therefore, this vision is not only created for the market and possible investors, but also to align the company towards a shared goal. As the impact of emerging technologies in the mobility industry, several companies have also formulated visions. For more information, see Appendix E: Vision of other companies on future mobility. ➤

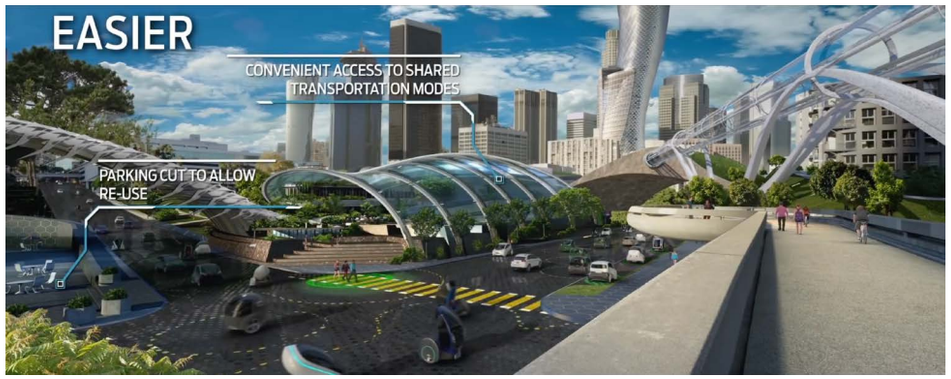


Figure 36. Vision of Ford: The 'City of Tomorrow' (www.corporate.ford.com)

Figure 37. Apple's innovations towards the iPhone

Changes for mobility users

Users are an important factor for technological changes as they are the ones using the vehicles, in one way or another (transporting themselves, or delivering / receiving a good or service). The disruption in the mobility market is going to affect people in several ways (e.g., ride sharing). Before anything is going to change, users must accept the technology. Therefore, mobility providers have the responsibility to introduce acceptable products and services. New technologies face the challenge of not being accepted by its users (e.g. Apple's introduction of the Newton tablet and the Google Glass). In theory this is called the MAYA principle: *"Most Advanced. Yet Acceptable"* (Dam, 2017). One of the solutions for this problem is to advance your design gradually over time (see Figure 37).

For the automotive industry, Tesla shows an example of their first electric car still having an open grill (which they do not need), and gradually, eliminating it over different designs (Nas, 2016). The acceptance of changes in the mobility industry are (1) whether users accept that there is no human driver, (2) if users want to share the car with multiple people at the same time, and (3) how privacy can be guaranteed but services can be designed for personal fit.

NO HUMAN DRIVER

As autonomous vehicles do not need a human to move, users need to feel comfortable giving control of the vehicle to technology. Imagine yourself driving on the highway and letting go of the peddles and steering wheel at 120 kilometres an hour, letting the vehicle take over. Also, would this be different if there was no steering wheel or pedals to begin with? Mobility providers need to prepare users for this change if they want the technology to be accepted.

Studies on the adaptation of autonomous vehicles show positive attitudes from users (Mosquet et al., 2015; Silberg & Wallace, 2017). Participants' perceived usefulness and perceived ease of use both scored positive when evaluating partially AV (using the Technology Acceptance Model of Davis, Bagozzi, & Warshaw, 1989). Other findings state that technology acceptance from AVs not only depends on the vehicle, but also on the context (technology, society and nature) and the system in which the technology is placed.

Although studies show positive signals towards the acceptance of autonomous technology, users find it hard to imagine how they will react to radical innovation. Question that arise for this topic:

1. How do people feel about giving control to the car?
2. How do people feel about loved ones giving control to the car?

It is difficult to answer these questions before people can actually try and use the technology. From prior examples - such as the WEpod or the autonomous shuttle in Rotterdam – had no trouble with accepting that the pod was in control. ➤

SHARING

Technological developments (as is described in Chapter B4: Technological developments) open a new era for innovation in the mobility sector as they reduce pollution, parking space and, traffic jams and moreover, increase safety. One of the possibilities with a large impact are different mobility sharing models.

"It time to bring our streets, into the sharing economy."- (Hackett, 2018)

The fundamental motivation behind car sharing is that car ownership takes in a lot of space in the city and cars are parked most of the time (Alessandrini et al., 2015). Mobility sharing can mean two different things: (1) multiple persons using multiple cars (car sharing), or (2) two or more people using one car at the same time (ride sharing). Car sharing is already on the market by companies such as Car2Go, Greenwheels and Amber.

Car sharing (see Figure 39) is creating more and more popularity. In Europe alone, from 212,000 memberships in 2006, towards 552,000 memberships in 2010 (Alessandrini et al., 2015). Platforms such as Greenwheels and Car2Go offer a fleet of vehicles for customers to share which solves mobility problems in urban areas (less C02 emission, less parking, less traffic, time efficient and less costs; - Alessandrini et al., 2015; Kalmbach, Bernhart, Grosse Kleimann, & Hoffmann, 2011; Lipson & Kurman, 2016).

Ride sharing is a movement that will increase efficiency even more. With car sharing models, the person still uses the car alone. With ride sharing, the car can be used by multiple persons at the same time. This could drastically save costs of transportation as multiple people can share the cost of the ride.

For an overview of all key differences see Table 2. One of the hardest challenges is if users will be open to share a vehicle with multiple persons and in what kind of context should this be offered. To ask a simple question: *"Would you let your under aged child travel in a shared vehicle with strangers?"*

As Figure 38, Figure 39 and Figure 40 show, ride sharing is the option where space is preserved the most because one vehicle can transport multiple people at ones. However, these kind of new sharing models are not depending on autonomous technology. An example of a ride sharing service is already being introduced called MOIA (www.moia.io).

Mobility sharing is becoming more popular every year. Advantages of sharing are: more social cohesion, less C02 emission, cheaper mobility, less parking, less vehicles (Hackett, 2018) and therefore, more efficient mobility is created. Still, with sharing initiatives being accepted, it is the question if these services will become a dominant form of transportation. Therefore, more research needs to be done to determine if more target groups (e.g., families) and other contexts (e.g., weekend shopping, soccer practice or social visits) are interesting for sharing ➤

Figure 38. Car ownership

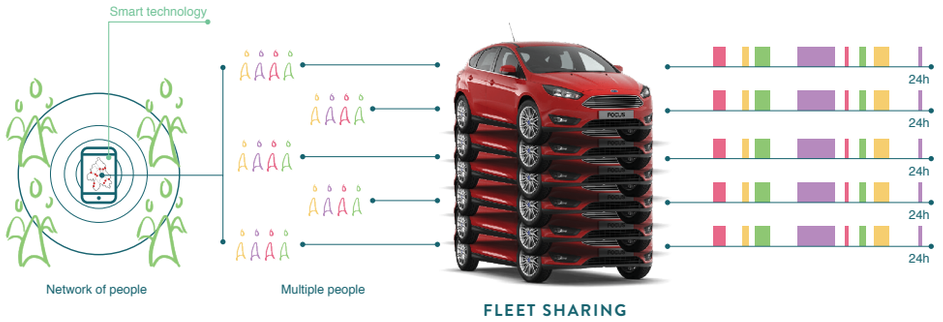


Figure 39. Car sharing

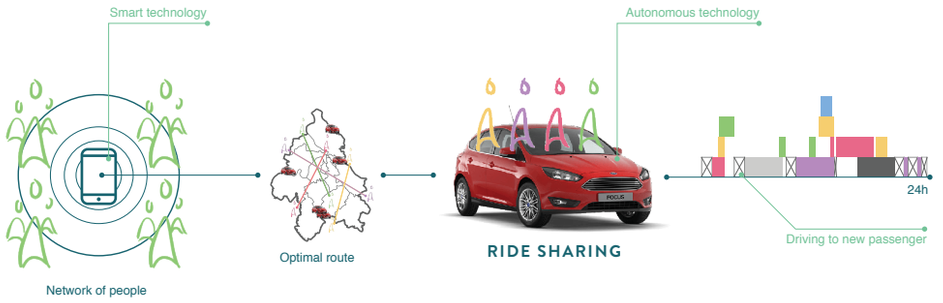


Figure 40. Ride sharing

Table 2. Different sharing modes

	CAR OWNERSHIP	CAR SHARING	RIDE SHARING
OWNER OF THE VEHICLE	User	Company that offers fleet of cars	?
PAYMENT	Pay for product	Pay per time/mile used	Pay per time/mile used devided by persons using
USING THE CAR	Always only one user	Multiple users, one at the time	Multiple users, at the same time
HUMAN DRIVEN	Yes	Yes	No
ACCESS	Personal key	Through platform	Through platform
PARKING	As close as possible to the user Personal parking spot in city	As close as possible to the users Shared parking spot in city	Where there is space Shared parking spot outside city

mobility services. Questions that arise are:

- How do users feel about sharing a car?
- How do people feel about losing the benefits of owning a car (flexibility, freedom, independence)?
- How much people would like to share a car?
- How much people would like to share a ride?

These questions are outside the scope of this assignment because of the need for in-depth user research but need to be included in the overall URP of Ford and IDE.

OPEN DATA

An overall societal problem that technology companies face is the increasing amount of personal data. Data is very valuable for companies as they can derive behaviour (e.g., social, commercial or logistic) from it and therefore, design their services accordingly. However, people are withholding the amount of data they want to share (e.g., the Dutch example of the referendum for the 'Sleepwet', www.sleepwet.nl). The reason for this is that people do not want large organization to know personal thing about their own lives. Governments are still trying to figure out what the impact of data is and what guidelines or restrictions they should provide. In Germany for example, the use of Google Street view is not allowed.

For automotive companies, this is not a major issue at the moment as ownership was with the user and data was kept inside the car. If mobility services want to succeed, customization through data is essential for user acceptance, creating a paradox: users do not want to share personal data, but personal data is needed in order to improve mobility services for users.

Just as the previous sections (no human drivers & mobility sharing), people need to see the usefulness and the ease of use before acceptance occurs. This will happen over time as early adopters and innovators will guide the way for majority (see Figure 41).

In a recent presentation of Ford's CEO (Jim Hackett) at CES (Consumer Electronics Show), he explained that dealing personal data is a real concern of people and that Ford is already trying to look for solutions to guarantee safety and privacy.

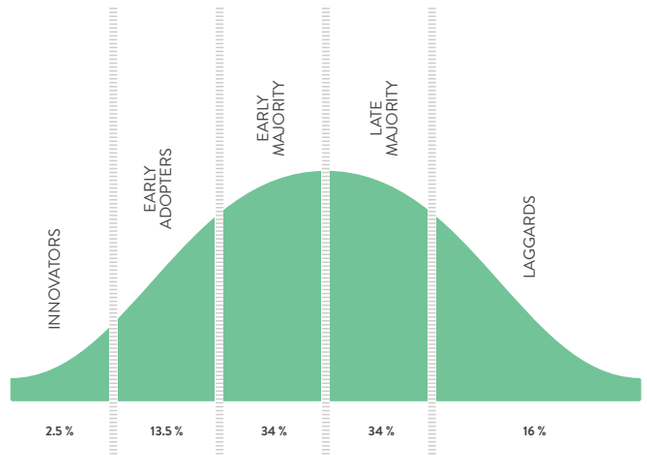


Figure 41. Adoption curve

Conclusion

This chapter described the changes in the automotive industry with a focus on autonomous technology. First, three major technological innovation (electrification, digitization and autonomous technology) are being developed that are causing new opportunities for the mobility industry (the ability to offer Mobility as a Service). It is important that mobility providers work together in order to create an efficient mobility ecosystem. Society could benefit from this movement as it partly solves global issues such as global warming and traffic congestions, creating more space and improving the quality of life in cities. However, new mobility solutions need to be tailored to the needs of people and customized in order that they will be accepted.

From the research I did on ecosystems, the environment and autonomous technology, trends and development can be filtered and described. These trends, together with the insights of experts, are the foundation of the vision on future urban mobility. ■

5. TRENDS DERIVED FROM RESEARCH

The dictionary defines a trend as ***"a general direction in which something is developing or changing"*** (www.oxforddictionaries.com). The previous chapters describe technological changes and the ecosystem/ environment where the change could happen. Until now, all research was divergent, exploring the context of urban mobility. This chapter clusters that information into trends and developments. After Part B, I converge these insights into a future vision on urban mobility.

Figure 42. Important trends

Besides the previous chapters, an in-depth trend research is done (which also includes Ford's own trend research) to check if trends from all directions are accounted for in this thesis. For the full research, see Appendix F: Trend research. The identified important trends are visualized in Figure 42.

The trends research was aimed to provide a good sense of the future. Ford's trends research correlates with my own research which gives one main direction: *people first*. With the power the internet and social media, the public demands more transparency towards social and sustainable innovation.

In the vision of Ford in Chapter B5 (page 64), Ford wants to democratize mobility. This mind-set is precisely what they should think of when innovating towards Mobility as a Service to connect to the public. ■

6. EXPERT INSIGHTS

Several interviews were held with experts in the field of mobility (see Figure G: Experts), autonomous driving and city development. The experts were chosen to give a complete view on mobility of the future in urban areas.

Goal

The use of expert opinion is seen as a key resource in future oriented projects as it can full knowledge gaps, well as provocative viewpoints and counter arguments (Evans, 2011). The goal of the interviews is to get knowledge of current available innovation options in the fields of urban development and mobility solutions.

Experts

For the interviews, I used semi-structured interview guidelines. As areas of expertise differed, this approach gave me enough grip to discuss every subject, and enough freedom to steer the interview to individual opinions (for the research set up, see Appendix G: Set-up). The interviews were recorder where allowed and analysed. When analysing, I looked for possible correlations or differences in opinions on the subject. For a detailed description of the results, see Appendix G: Results per expert.

Insights

The biggest insight of these interviews was the following quote (said by every expert):

"Could be..."

This explains the uncertainty of current developments towards urban mobility. This means that Ford needs to be careful and keep an eye open for first initiatives in order to gain knowledge before implementing their own mobility solutions, identifying as the *"quick follower"*.

Social isolation

"I really live in a bubble, my groceries are being delivered, I step out of the car on my way to work. The only moment I leave my bubble and meet other people, is when I'm in the shopping street." - Connekt

People are becoming more and more isolated from their environment. One drives to work and back, gets their groceries delivered, and only visits their friends and family. AVs have the possibility of creating a bigger gap between social groups in a city.

Emission over autonomy

TNO explained that, for a municipality of a city, autonomous vehicles are not the highest priority. They are more concerned with an emission free city, which has more added value to the quality of life of the people.

Technology acceptance

"[about the autonomous shuttle in Rotterdam] Everyone was really concerned, expecting it would be problematic [the acceptance of such an AV], but that wasn't the case at all, not even on day 1." - WEpod

Several of the experts were convinced that the acceptance of the technology of autonomous vehicles would not be a problem. As long as there is an added value, people will use it. Especially is they are seeing other people using it.

Quality of life

"What do you want to be as a city? Healthy citizens, good facilities, happy citizens, good economy. So how do autonomous vehicles fit there?" - TNO

Autonomous technology will open a broad variety of possibilities. Transportation can be made more easy and comfortable. At this point, people often walk or bike the last mile of their journey. With AVs, this won't be necessary. Who are responsible for ensuring the health of people? The service providers, municipalities, or maybe people themselves?

Seniors

"You also see beautiful scenario's, where there is more social inclusion from people who are - at this moment - not able too."

Besides urbanization, another relevant development is the rapid growing elderly population. This part of the population is ➤

Table 3. Experts

TNO	WEPOD	SMART-PORT	CONNECT	LIGHTHOUSE	SUNIDEE	MOBIKE & OV-FIETS	GOUDAPPEL COFFENG
Director Smart Cities	Project leader	Portfolio manager	Manager ITS	Founder	Intern	Specialist & Founder	Urban planner & Urban designer
This expert is reponsible for Smart City development at TNO. Therefore, he has expertise and knowledge of current developments towards preparing cities for the future. He believes that flexibility is key with a long term view. Where traditional policy domains of mobility, economy, environment and infrastructure work together in order to help decision making today.	This expert is a specialist on innovative mobility solutions and was project leader at the first autonomous pod tests in the Netherlands. This WEpod is currently being tested in Delft. He was also involved in the autonomous bus innitiatives in Rotterdam which already drives for many years.	Smart-port in a knowledge institute which is specialized in create smart solutions for brainport Rotterdam. On the things the expert is focussing on is for example platooning from and towards the ports in Rotterdam. Smart-port is not so much specialized in urban mobility.	Connekt is an independent network for smart, sustainable and social mobility. With over 500 partners globally, Connekt realises tangible for a sustainable and economical better world.	LightHouse is founded to disclose the knowledge on smart lighting and smart cities of the Eindhoven University of Technology for Society. As one of the founders, the expert was also involved in creating several roadmaps together with Eindhoven on diffferent topics such as lightning, mobility and living.	Sunidee is a strategic design consultancy. The expert is involved in a program together with Deborah Nas (founder of Sunidee and professor at the TU Delft) to set up new mobility strategisch that are focussing around bicycles and bicycle sharing.	The expert is the founder of the OV-bike with the vision of having a bicycle in every city. In 2017, around 14.500 bicycles are available at more than 300 locations. Currently, the expert works for Mobike which is a new bike-sharing service which just enrolled its service in Rotterdam.	The experts from Goudappel Coffeng both work in at a consultancy that focussing on urban development. There jobs entail the design of new infrastructure in cities. Their approach is looking at different variables in urban mobility:
GOAL	GOAL	GOAL	GOAL	GOAL	GOAL	GOAL	GOAL
To recieve knowledge on smart city development and broaden my scope from autonomous technology, towards sustainable urban mobility.	To receive knowledge on current initiatives on autonomous vehicles in the Netherlands. Also, the learn how current iniatives are being viewed on technology acceptance by society.	To receive knowledge on smart mobility solutions and possible implications. To learn which time of technology will be implemented first.	To receive knowledge on current partnership and willingness to cooperate with each other. Also, to get an outside perspective on autonomous technology.	To receive information about Eindhoven and developements that are taking place there. Also, to learn for her experience with envisioning future mobililty and translating this into a tangible roadmap.	To learn from each other in the process of getting to know mobility and emerging strategisch. Also, to access her network for enabling connections in Eindhoven and other experts in the field of mobility.	To receive information on other mobility opportunities then car. To see urban mobility not only with new automotive technologies, but as a larger scope (i.e., sharing economy).	As I am a strategic product designer, I had little knowledge how cities are designed and managed. Therefore, to learn from professionals in the field of urban design and to see how they tackle design problems now, and how they see this shift in the future.

3.

often lonely and sometimes immobile. AVs can have a lot of added value for this group as it can stimulate social interaction as mobility.

Space
Besides pollution, space is one of the biggest challenges of urbanization. Therefore, individual transportation will be pushed out of the city centre gradually. Vehicles who want to move within this zone, should have a sharing ability or other goal then individual people transport (e.g., delivery or maintenance).

Popularity of bicycles
Because of a shortage of space, municipalities are investing in a safe biking and walking environment. Especially in the Netherlands, people will bike when they are able to, even in bad weather. With the implementation of bike sharing services, also people who are visiting a city can move by bike.

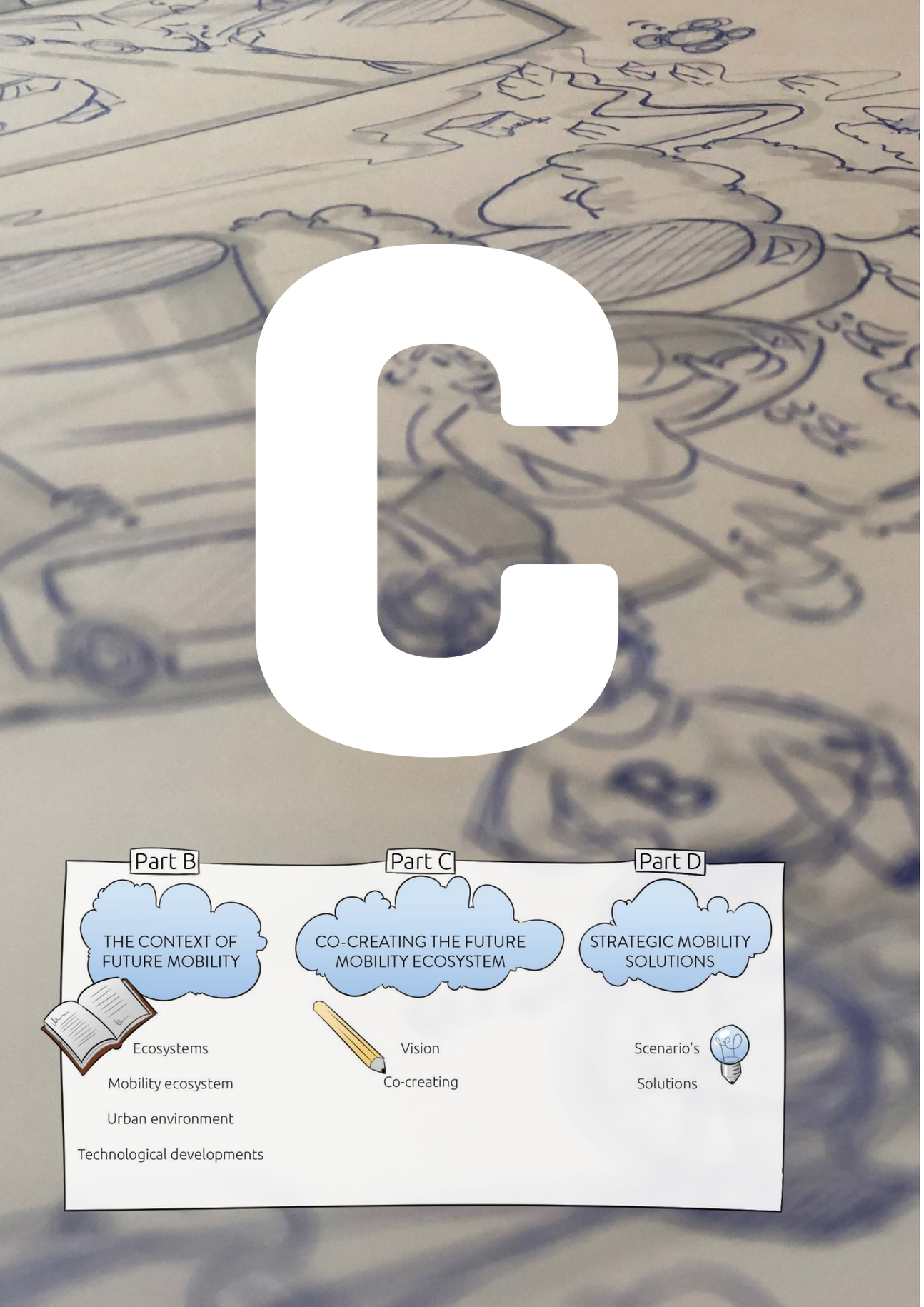
Collaboration with public transport
In order for the mobility ecosystem to function as productive as possible, people need to share transport. If autonomous shared vehicles become cheaper than public transport and fulfil door to door transport, people will start moving from larger vehicles into smaller vehicles, which is not efficient in the sense of space. Therefore, business models should be adjusted so people pay for how much space they use on the infrastructure.

Transition
The moment when it is proven that AVs are safer than human driven vehicle, the transition is going to develop exponentially. Other examples of these transitions are the situation of a dangerous intersection. Nothing happens until it is proven that the intersection is dangerous. When an accident happens, people will push the municipality to act on creating a safer intersection. When proven that AVs are safer than human driven vehicles, people will protest every time someone dies because of a human driven vehicle, pushing the transition.

Conclusion

Together, the analyses, trends and expert insights serve as a foundation towards a vision of future urban mobility. In general, the experts gave autonomous technology a place in the mobility ecosystem. Autonomous technology is not something holy that could solve everything but has some spots where it can have great benefit to the system. Those spots need to be found instead of just making everything autonomous and see what happens.

With technological developments going so quickly, it is hard to be sure where it can add value in the ecosystem. Therefore, modularity in the technological implementation is important in order to quickly adapt. ■



CO-CREATING THE ECOSYSTEM WITH STAKEHOLDERS

At this point, all information is gathered, structured and analysed. From this work, I started to formulate a vision. A vision is useful for aligning stakeholders towards the same goal and helps to get a shared understanding of the future. Future visions often express an innovative product-line from a company perspective in order to prepare the company itself, stakeholders and customers for the future. The goal for my vision is to trigger conversation and iteration with stakeholders of the mobility ecosystem. Thereby enabling a shared understanding by iterating the vision together with stakeholder input.

1. A DESIGNER'S VISION

As mentioned in Part A5: Design approach, a method of visualizing is used that is often seen in my education. The vision, which often contains multi interpretable text (e.g., sustainability, innovative pioneer or technological frontrunner) that is hard to translate into specific actions. A visualization of this text into a 'Praatplaat' helps organization to translate abstract terms into (often) metaphorical actions.

In Figure 43, the benefits of 'Visual Thinking' (in practice used term) are displayed in a 'Praatplaat'.

I chose not to digitalize the Praatplaat directly but first iterate it with stakeholders as it would show an unfinished picture. Therefore, I created more ownership as every stakeholder could co-create the definitive result.

Before I could translate all the results into a visual, I defined different variables that should be mentioned (see Figure 43). Sub-visions are described (see Appendix I: Sub-visions) in order for me to get an overview of this complex ecosystem. Eventually, those variables are all included in the vision as can be seen in Figure 45 on page 84. ➤

Figure 43. The benefits of 'Visual Thinking' explained in a 'Praatplaat' (Liende van der, 2017)

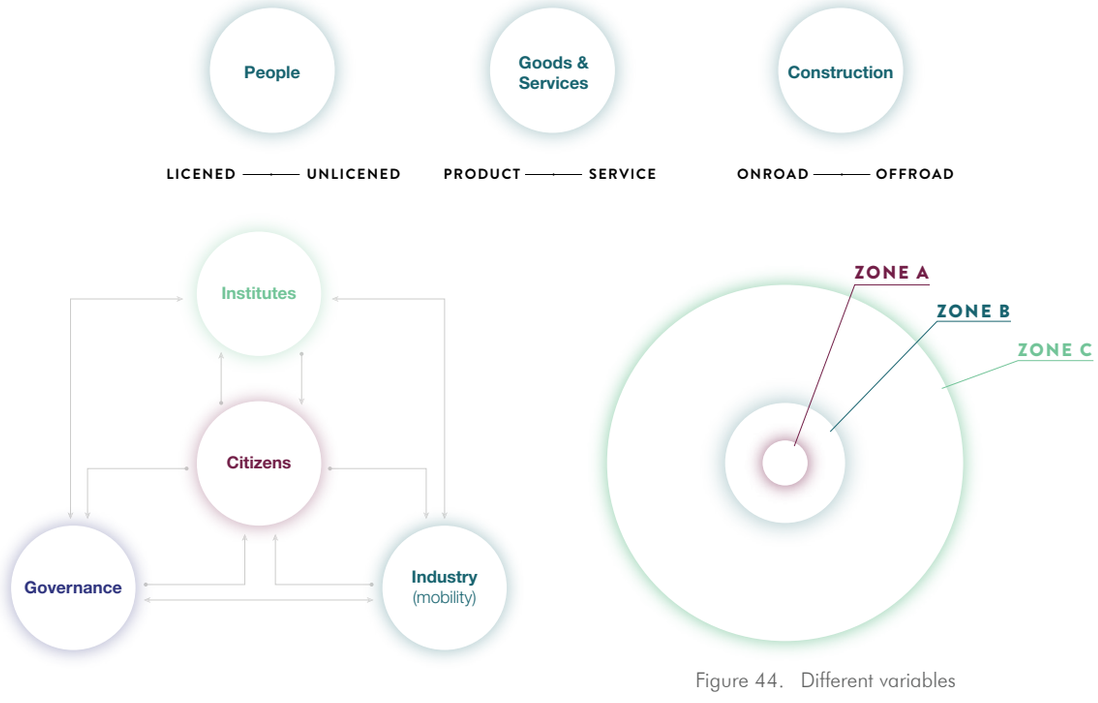


Figure 44. Different variables

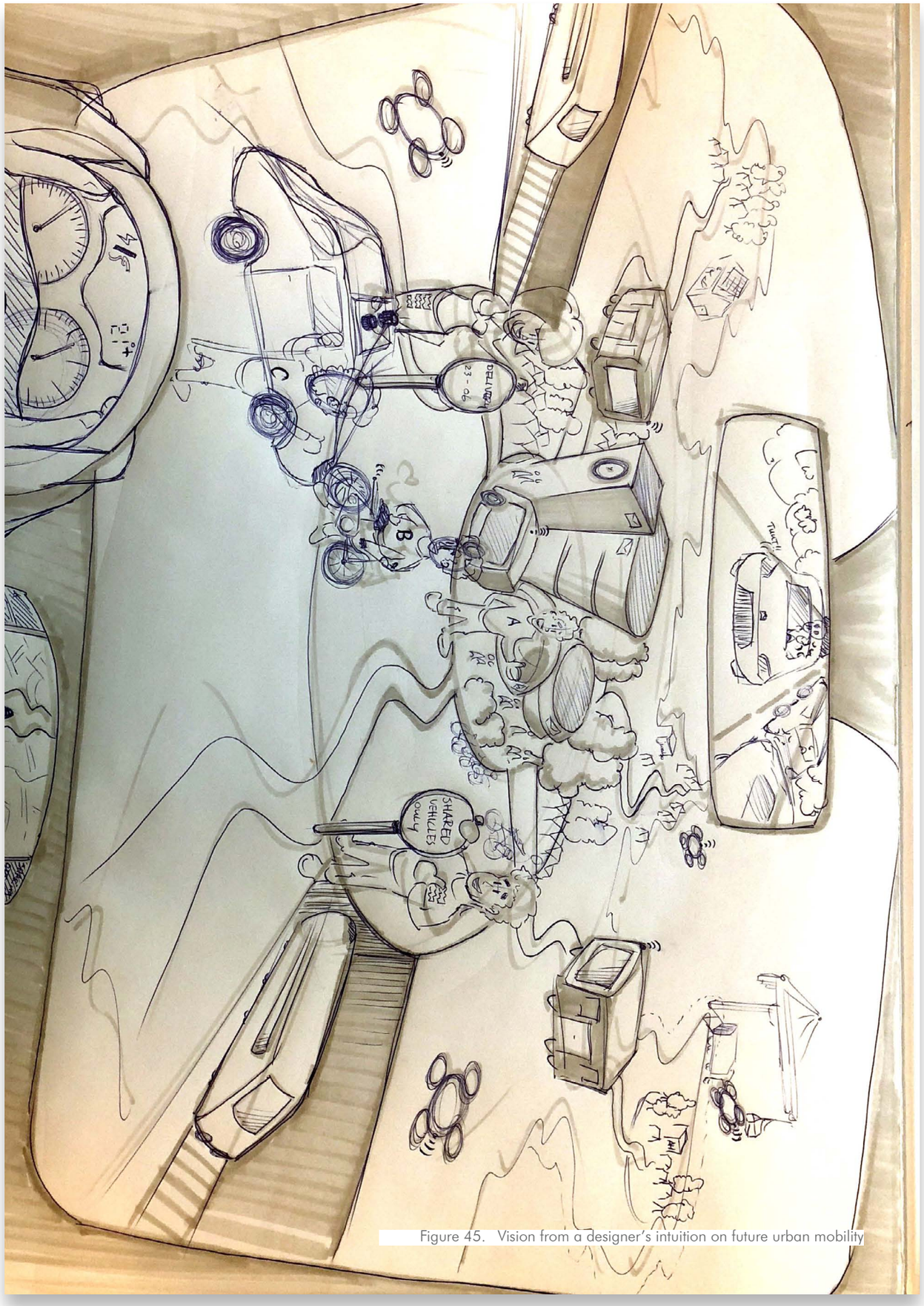


Figure 45. Vision from a designer's intuition on future urban mobility

The first element is the metaphor of the car this is being driven. In rear-view mirror, the past is shown with congestion, pollutions and unsafe situations. In the car is the present, therefore the driver is still holding the wheel (and not driven autonomous). What is shown in the window is the city of 2030.

De second element shows the three different zones of the city (A, B & C) with their dominant mode of transport (A: walking, B: biking, C: driving). In zone A, only autonomous shared vehicles are available for driven transportation within the zone. By clearing the zone of individual driven transportation, space is created for pedestrians with green and social zones. The bicycle is dominant in zone B, making any driven vehicle a guest. With improved infrastructure and widely available (electric) bike services, biking will become even more popular. If you still have the need to go by a driven vehicle, it needs to be shared in this zone. As space is still a luxury, the municipalities force regulations for entering the city with personal vehicles and how they are powered (electrification against global warming and pollution). The personal vehicle (autonomous or not) is still dominant in part C as it is designed with cars in mind. Due to urbanization, new ways of working for commuting are stimulated to prevent congestions in peak hours.

The third element is the role of public transport which is very important for mobility in cities as it can transport large amounts of people which still occupy most of the current infrastructure. For the first vision, the train will be underground, creating more space on the surface. The train has little advantage in for transportation within a city but more for transportation between cities. Busses are still available but more in a 'tram' model. Busses will not drive to every corner of the community but will driver more often on faster sections.

For delivery, drones will be available in the suburbs as there is space for individual delivery (harder for flats in the centre). In the centre, pick-up points will be available on popular spots (such as the central station). Most of Business to Business (B2B) delivery will be done at night to distribute peak hours. ■

2.

CO-CREATING WITH STAKEHOLDERS

Innovation in the mobility system is a team effort. In order to create a vision where everyone agrees on, iterations are made with stakeholders (see Figure 46).

Goal

The goal of these iteration was to understand the value stakeholders believe they currently add in the system and how they see this shift in the future with the implementation of new technologies. Also, what I wanted to learn is what their core values were as a company and how far they look into the future. Finally, I wanted to know if new technologies could benefit their value and Ford's.

The results of the stakeholder iterations are mapped in value exchange in the ecosystem. For detailed results on the stakeholder iteration, see Appendix H. In Figure 47, a visual representation is shown of how the insights are displayed. This graduation assignment represents the institute in the general map (see Part B1) as it provides and distributes knowledge and research. The insights display the role of the municipalities, industries and citizens for each stakeholder. As Ford is the initiator for this project, each stakeholders value for Ford is also given. ➤

STAKEHOLDER	SECTOR	FUNCTIONS	ROLE
Ford	OEM	Innovation Management Supervisor - Innovation Management, Mobility Research Innovation Management	Initiator
NS	Public transport	Formulemanager autoparkeren, deelauto en bagagekluizen Programmamanager Ketenmobiliteit	People transport
ProRail	Public transport	Technisch Trainee | Ontwikkeling & Beleid – Stations Adviseur Bestuur en Ondersteuning International Affairs Programma manager ProRail stations	
ARRIVA	Public transport	Vervoerontwikkelaar	
PIC NIC	Logistic - Delivery	Fleet Manager Teamleader	Goods & Services
DHL	Logistic - Delivery	Project Manager - Sustainable innovation	
postnl	Logistic - Delivery	Manager Technology & Innovation Project Manager Technology & Innovation	
spaarne landen	Waste management	Communicatieadviseur Directeur Productmanager	Construction & Maintenance
Haag Wonen	Social housing	Financieel directeur	
EINDHOVEN	Municipality	Verkeersplanoloog - fietsen Verkeersplanoloog - zero emission	General
Rijksoverheid	Government	Urbanist	

Figure 46. Stakeholder iterations

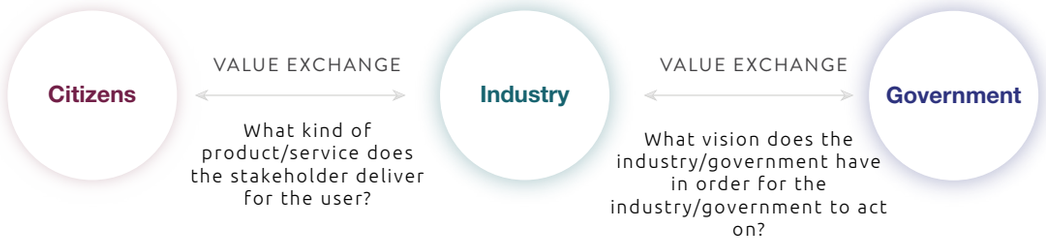


Figure 47. Value visualization

GENERAL

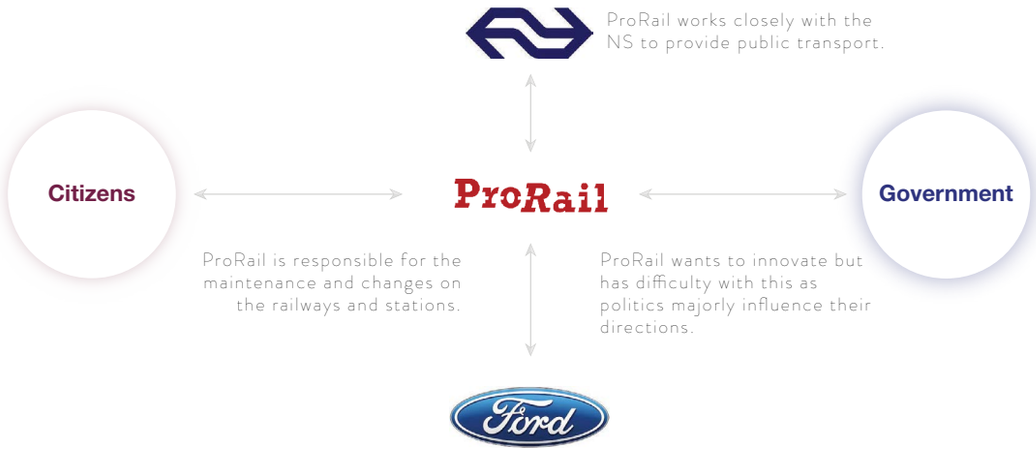
Currently, Ford add value to the ecosystem by the design and production of motorized private and commercial vehicles.

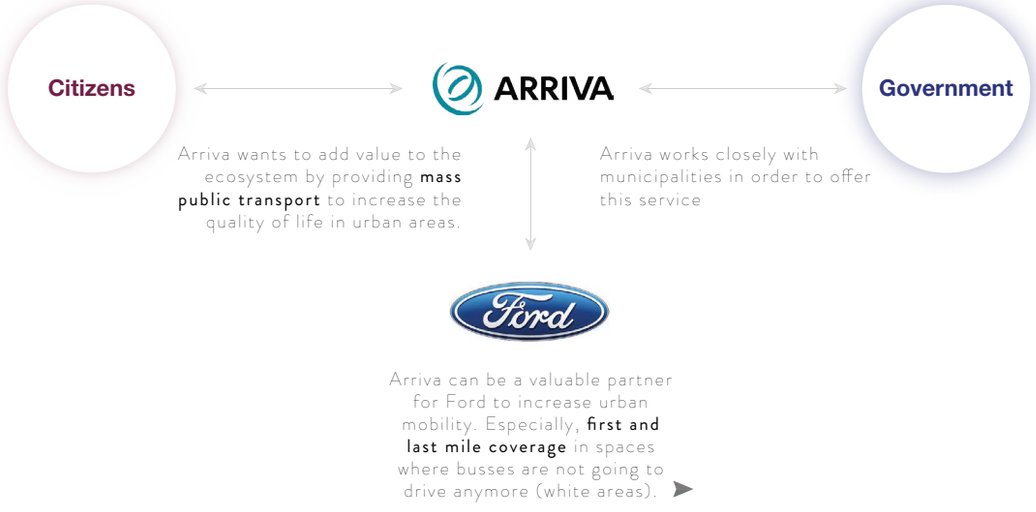
The main focus point for Eindhoven is to become **emission free** (Eindhoven does not have the problem of space as much as other cities). Still, they see a lot of opportunities for **autonomous technology** and are eager to collaborate with other parties.

Currently, Ford add value to the ecosystem by the design and production of motorized private and commercial vehicles.

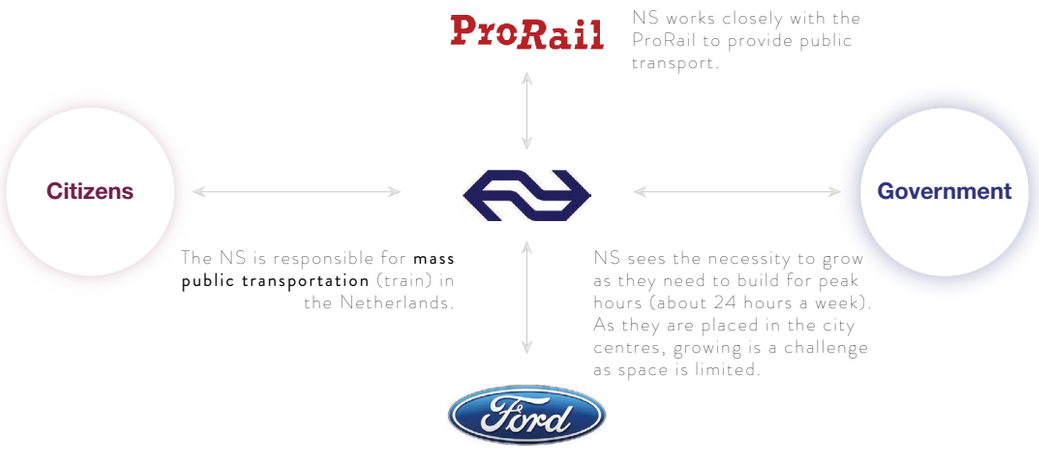
The Rijksoverheid has the responsibly to look for options to improve the quality of life in the Netherlands. The Rijksoverheid also sees disruptive changes in the ecosystem with a lot of opportunities, but also dystopian views. Although their first priority was electrification, the Rijksoverheid also sees opportunities in autonomous technology.

PEOPLE TRANSPORT

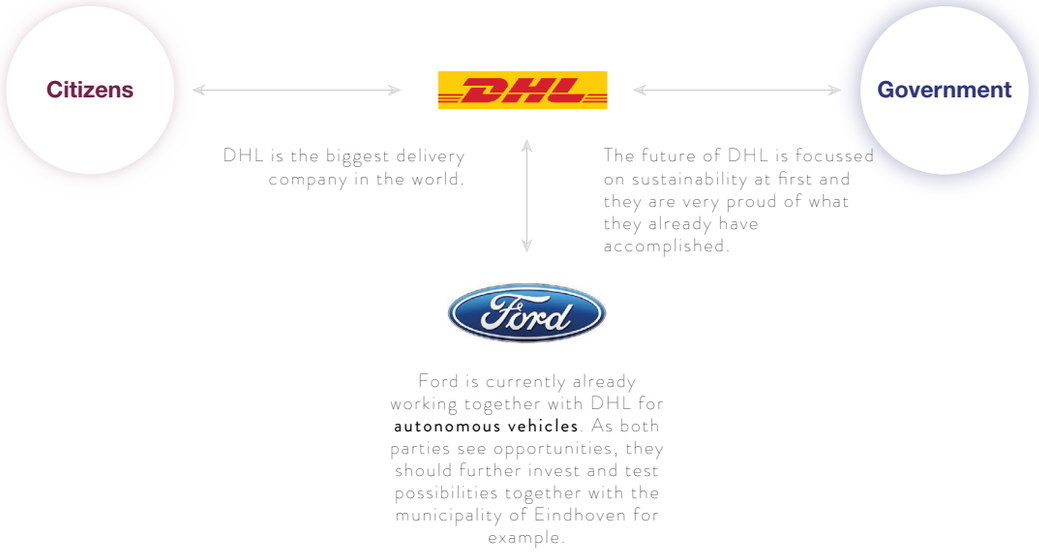




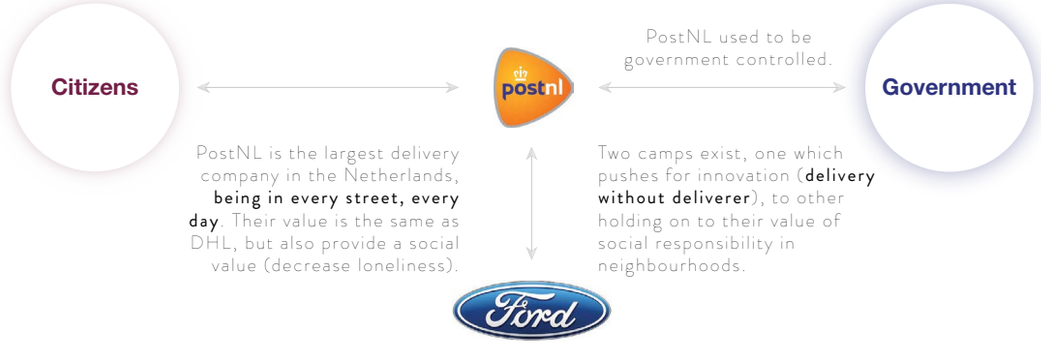
PEOPLE TRANSPORT

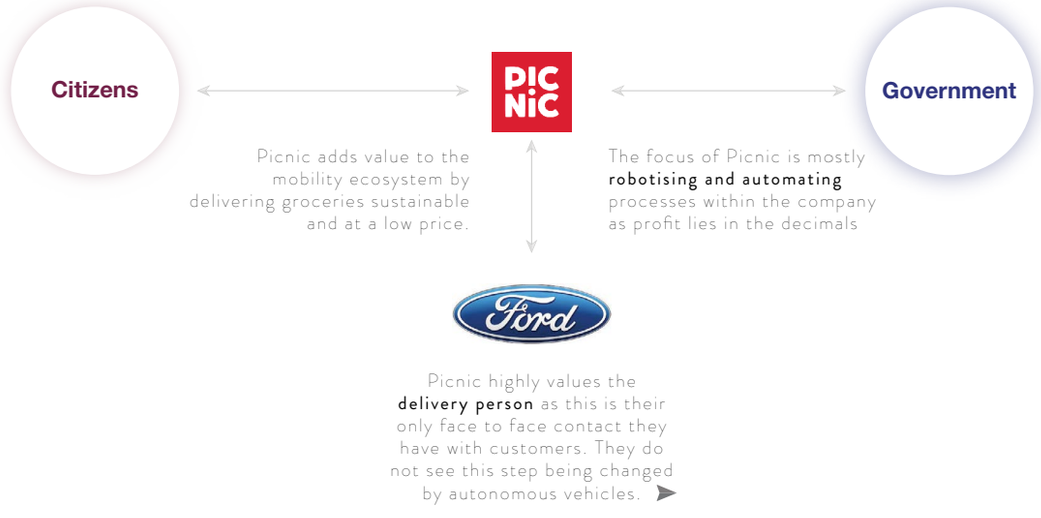


GOODS & SERVICES



GOODS & SERVICES





CONSTRUCTION & MAINTENANCE

Citizens ⟷ **Haag Wonen** ⟷ **Government**

As a social housing cooperation, HaagWonen has a very social and ethical role. They try to involve themselves in urban innovations to increase the liveability of The Hague.

HaagWonen is very committed towards a **sustainable future**. As a social housing cooperation, they work closely with municipalities to accomplish emission standards.

Ford

For Ford, HaagWonen can be an interesting party for the **commercial vehicle market**.

Citizens ⟷ **spaarnelanden** ⟷ **Government**

Spaarnelanden is responsible for waste management, parking and mobility services in Haarlem. They are motivated to change towards **electric mobility** and finding solutions for the **shortage of parking spaces**.

Spaarnelanden is the **arms and legs** of the municipality, they are closely in contact with the people. Therefore, they really see and feel the participation society and work towards local solutions.

Ford

Spaarnelanden was very enthusiastic about Ford's vision and giving the streets back to the community. This aligns with their own vision. Therefore, Ford can collaborate with them for possible implementation of **car sharing services** (i.e., Chariot).

With every stakeholder, the vision was iterated accordingly (see Figure 48). Overall it was very fulfilling to see the enthusiasm and interest for this topic from every stakeholder. Finally, I held a validation session at Ford in order to discuss the outcomes and the vision. The team at Ford was very enthusiastic and interested in the results of every stakeholder (even skipped meetings). On the next page, the digitalized version of the vision is presented. ➤

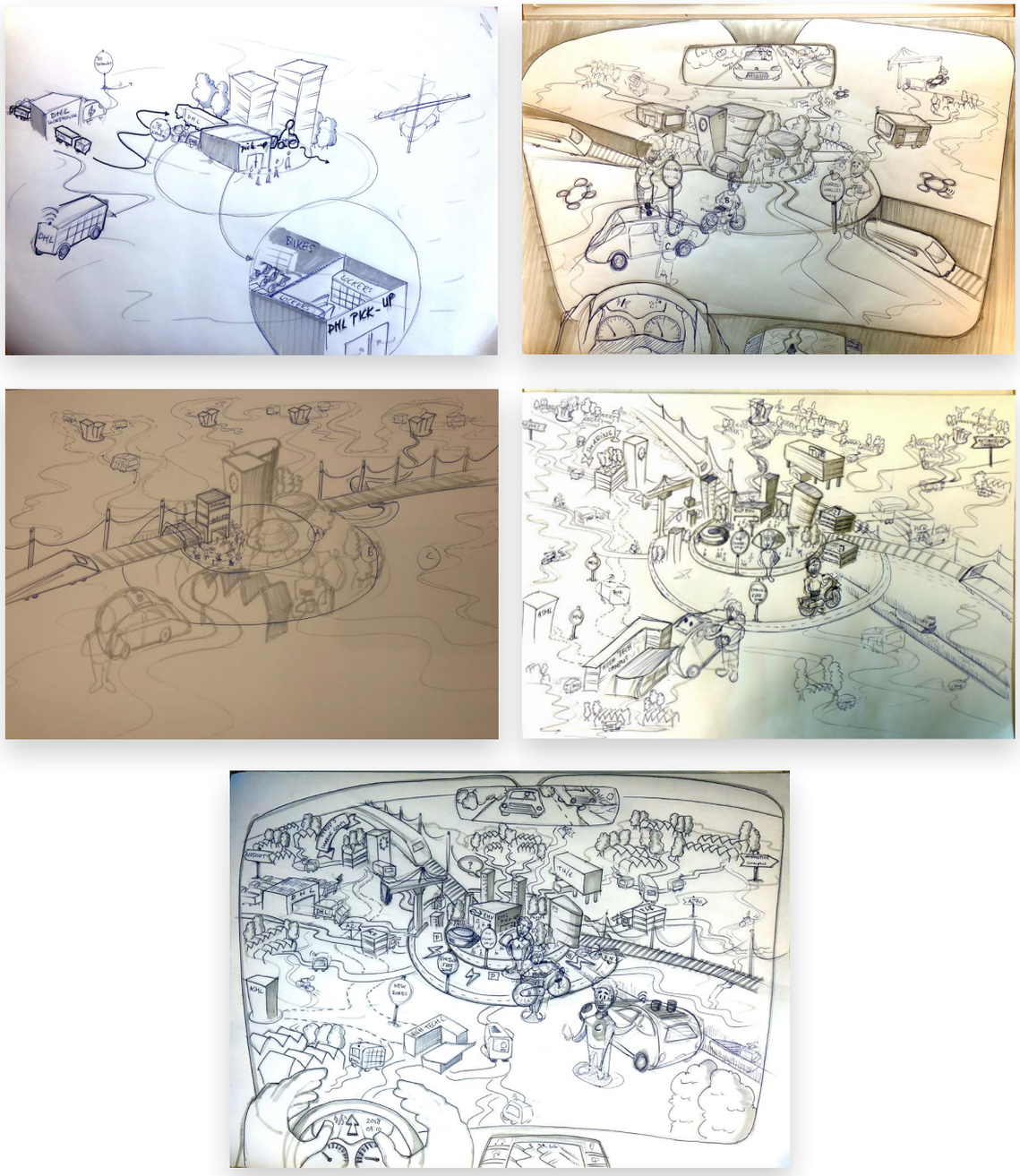


Figure 48. Vision iterations

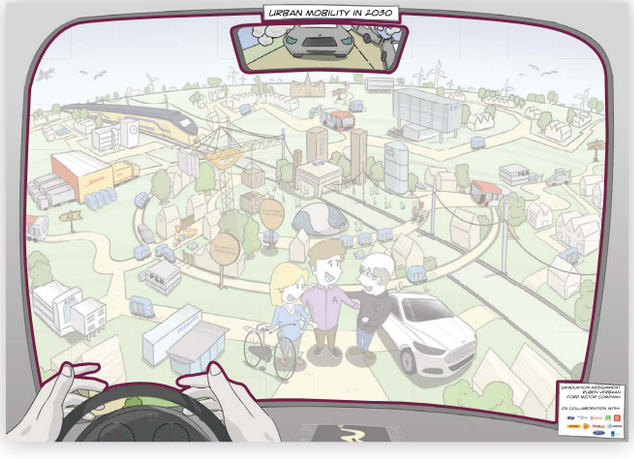
URBAN MOBILITY IN 2030

A50
A270
A2
TU/e
P&R
P&R
ASML
PHILIPS
DHL
No individual transportation
Only electric transportation
A
B
C

GRADUATION ASSIGNMENT
RUBEN VERBAAN
FORD MOTOR COMPANY

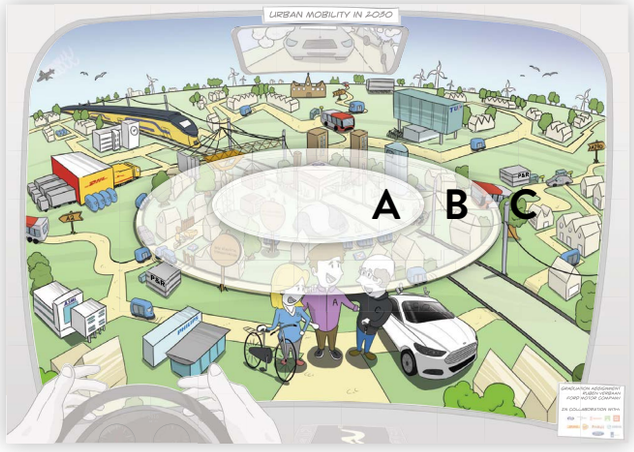
IN COLLABORATION WITH:

LEVEL 1: CAR METAPHOR



The first level of the visual represents a metaphor with reference to the timeline of the change towards improved mobility. The past is displayed in the back mirror of the car, showing traffic jams, fossil fuelled cars and unsafe situations. Within the car the present is displayed, with our hands letting go of the steering wheel. This represents autonomous technology which is almost ready for implementation. Lastly, the view in the window is the future, displaying urban mobility in 2030.

LEVEL 2: URBAN ZONES



The second level in this visual represents the different urban zones. The inner circle displays zone A: downtown. This zone represents the city centre of Eindhoven. Where Eindhoven is building towards more living areas and investing towards zero emission. The middle circle represents zone B: pre-war area. As Eindhoven wants to get rid of their abundance in parking spaces, liveability and quality of life can increase as these areas can be transformed into social and green environments. The outer area is zone C: suburbs. Here you can see the transformation of public transport (busses) and the added value the first and last mile transport can facilitate. Also, large industries in Eindhoven are established here.

LEVEL 3: DOMINANT MODES

The third level of the visual displays the different dominant modes I see in the different urban zones. The three people represent each zone. The man in the middle represents zone A. With his sneakers, walking is the dominant mode of transportation in Downtown areas. The woman on the left represents zone B. Her bicycle reveals that biking is dominant in this zone, infrastructure should be designed accordingly. The older man on the right represents the dominant mode of transportation in the Suburbs: the car. Since I do not believe that the individual car will be removed from this zone in 2030 with its clear benefits of freedom, independence and flexibility.

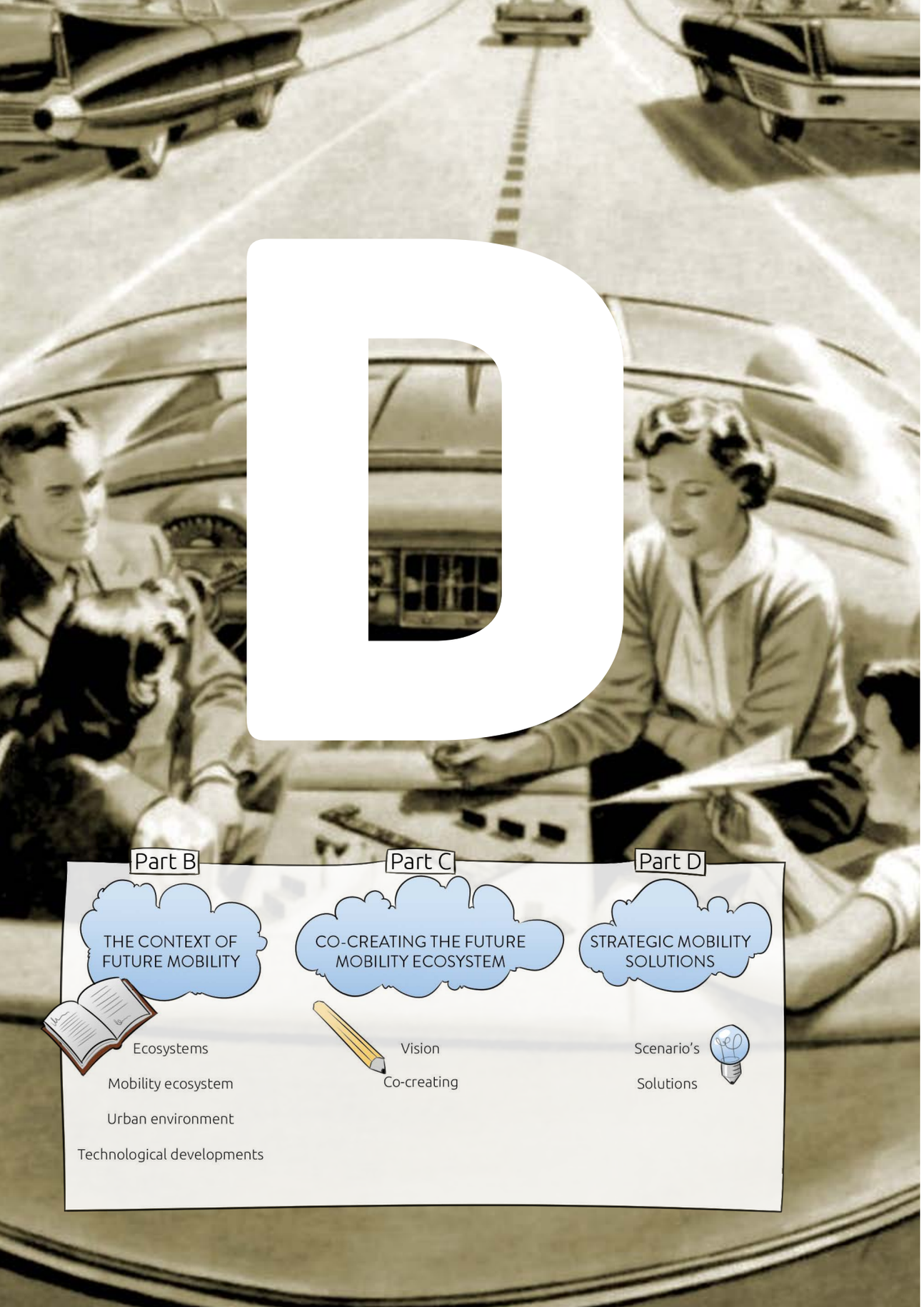
LEVEL 4: MOBILITY USERS

The last level represents the different types of mobility users in the ecosystem: (1) people transport, (2) goods & services and (3) construction and maintenance.

Goods & services

People transport

Construction & maintenance



STRATEGIC SOLUTIONS FOR FORD

The vision acts as a guideline from which new mobility solutions can be extracted. First, I will elaborate on different variables for the strategy. Second, I will specify which opportunities I see for Ford as a stakeholder in the ecosystem of future urban mobility. Finally, I recommend three favourable mobility solutions for Ford in this ecosystem.

1. STRATEGIC SCENARIOS

Although we are responsible for shaping our own future, it is hard to predict it. By accepting that the future is not pre-ordained, the more effort spent trying to understand the future, the more possibilities we may be able to shape (Fraedrich, Beiker, & Lenz, 2015). With technology developing exponentially quick, is us much harder to forecast the future than any other time in history. By understanding the variables that influence the outcome of technology, Ford can be more flexible in carrying out their strategy. Different scenarios that I will discuss are (1) level of impact, (2) type of ecosystem, and (3) business models.

Level of impact

Autonomous technology can have several levels of impact on civilization (see Figure 49). This depends on user acceptance, industry collaboration and governmental regulations.

1. **Evolution** of driver assistance states that mobility stays the same, but the experience inside the vehicle enriches. Safety is a main driver as autonomous driving will eliminate human errors (this is also a value for the other impact levels). This scenario follows the approach how the automotive industry typically introduces innovation, which is in a stepwise manner in the pursuit of keeping a competitive advantage in the market (Fraedrich et al., 2015).
2. **Revolution** of automobile usage means that digitization will have a large impact on the automotive industry. The vehicle becoming a gadget where product-service combination can made possible.
3. **Transformation** of personal mobility is the most extreme and the most beneficial for our society as it increases mobility. In this scenario (which we currently all steer towards) the mobility industry reinvents themselves, with new start-ups and services disrupting the market.

What I currently see happening is a focus on the transformation of personal mobility by traditional OEM's and new to the market firms. This level of impact, unfortunately, is slow because technology is not ready yet and new government regulations are needed which take time. However, I still think Ford should focus on the transformation of mobility because of the benefits it can have on the quality of life and mobility in urban environments.

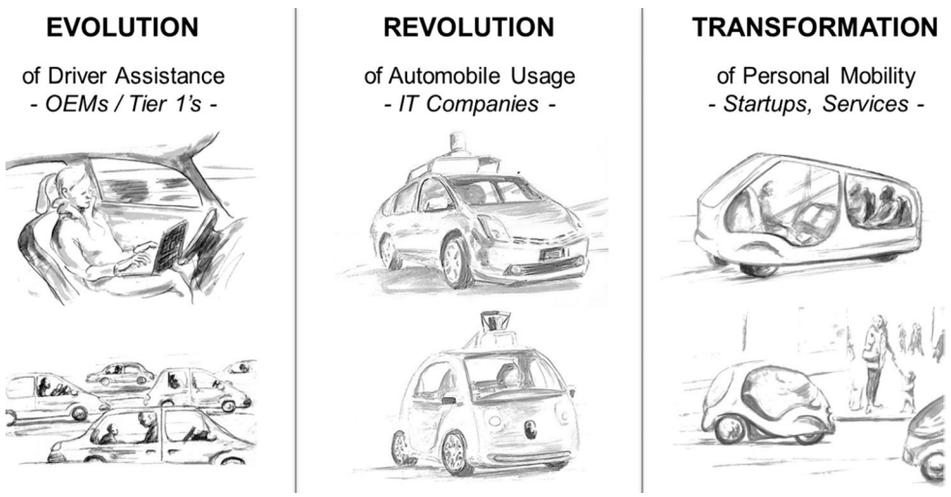


Figure 49. Levels of impact (Marlette, 2014)

Type of ecosystem

In 2030, as the technology reaches a point for urban-scale implementation, three types of mobility ecosystem can emerge (see Figure 50). A socio-technical approach can be used to show that the future of urban mobility will depend on the competition between coalitions of innovative actors who support alternative transport systems (Marletto, 2014).

1. The **Auto-city** shows an ecosystem where the business model for selling products, is still dominant. Car manufacturers are investing in incremental innovation for propulsion technology towards electrification. This is the 'sit-back-and-see-what-happens' model, which is likely to occur, as the ecosystem and infrastructure is already in place.
2. The **Eco-city** is an ecosystem where governments, public transport and technology providers support the vision of a sustainable future and the creation of new mobility ecosystem (Marletto, 2014). This ecosystem stands or falls on stakeholder collaboration, therefore, is less likely to succeed. However, my research with stakeholders all support this vision, therefore, making it a feasible future.
3. The **Electri-city** is a fully integrated smart grid infrastructure, which include the management of mobility and electricity on a national level. As this would provide a most efficient and sustainability, it also takes very large investments from the government, therefore, this scenario is likely to happen in the near future. ➤

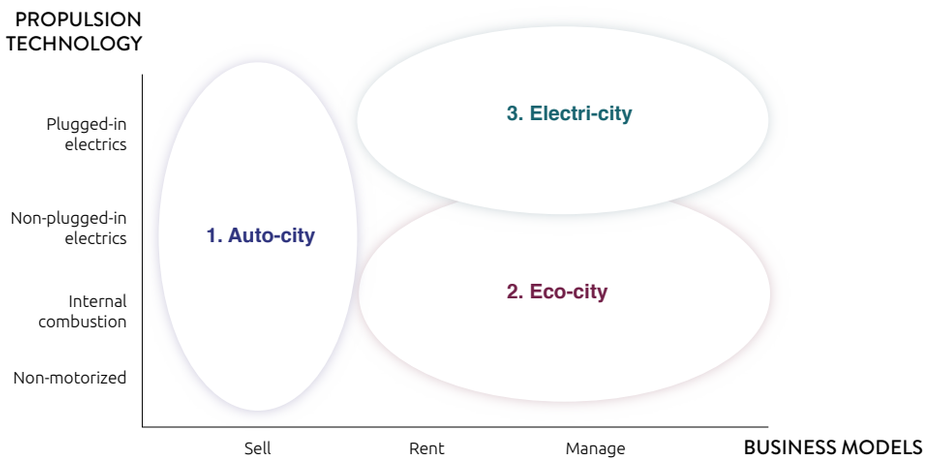


Figure 50. Type of ecosystem (Lerner & Audenhove, 2012)

The strategy for Ford should focus on the Eco-City for urban mobility in 2030. As technology is almost ready for implementation, time is still needed to mass-produce autonomous, electric and connected vehicles for an affordable price. As the Electri-city is a valuable vision to keep in mind, the Eco-city is the most realistic option as stakeholders are already acknowledging the need for collaboration.

Corporate business models

As the mobility ecosystem has the opportunity to change, product-, and service providers can also adapt their business models for this new ecosystem. There are three main business models that I will discuss, of course, these are not the only ones, but I hope it will give an idea of the scope (see Figure 51).

1. In the Google model, Ford will provide the mobility platform where other parties can provide services and products. An example of this is Ford's 'Transportation Mobility Cloud' (TMC), where all modes of mobility are combines in order to provide Mobility as a Service. Not only mobility modes are combined, as the platform also provides identification, information, booking and payment. Therefore, the platform provider should collaborate with other companies (e.g., banks or Telekom providers) (Lerner & Audenhove, 2012).
2. For the Apple model, Ford should provide all the necessary components, services and platforms in one premium mobility provider. As my research clearly steers towards open innovation and collaboration between stakeholders, this is not a business model Ford should pursue.
3. The Dell business model offers technologies (e.g., for rolling stock, infrastructure, traffic management and travel planning and information) and targets cities to which Ford could sell standalone solutions or targets city mobility solutions providers as system integrators (Lerner & Audenhove, 2012). The Google and Apple models also rely on Dell business model companies to provide technologies for their business.

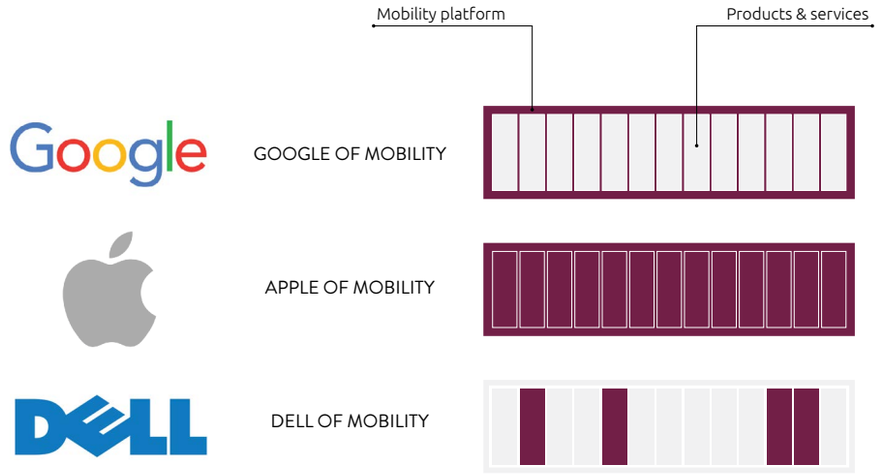


Figure 51. Corporate business models (Lerner & Audenhove, 2012)

Ford should focus on pursuing business models that fit their vision. Therefore, the Dell model suits best because Ford can tailor mobility solutions is specific areas in order to increase (democratize) mobility. As the Google role of this new mobility system is not yet filled, Ford also has an opportunity there to see if they could offer this platform. The 'Transportation Mobility Cloud' (TMC) is an innovation of Ford that is investigating if they could offer this. ➤

Conclusion

As said in Part A5: Design approach, Ford's role within the ecosystem is changing from product-centric innovation towards service-centric innovation with servitization and new radical technologies. Therefore, Ford can reinvent themselves as a mobility provider in the system of future urban mobility.

The scenario's mentioned above are important to keep in mind when designing products and services. Time will tell which future will exist, but together with stakeholders, Ford has the influence to shape the future mobility ecosystem. For now, I think that new technologies will have a transformative impact on the ecosystem. An Eco-city ecosystem is most likely to occur as all stakeholders that I talked to were planning for this direction. Lastly, it is hard to predict if Ford will be the globally main accepted platform provider. In the course of history, this spot is often filled by start-ups (e.g., Airbnb, Uber and Netflix). Therefore, Ford should focus on being the platform provider for local solutions in urban areas.

The next chapter will explain the mobility opportunities for Ford in urban areas which a gathered from research (trends, experts, and stakeholders). ■

2. AUTONOMOUS MOBILITY SOLUTIONS

The mobility solutions mentioned are a result of all the research that I did so far. Every solution is motivated by drivers and barriers from trends, experts, stakeholders and Ford. I divided the opportunities in people, goods & services and contruction (users of mobility infrastructure).

At the end of this chapter, I recommend three solutions for Ford to further investigate or continue with in the University Research Project. These three recommendation are also visible in the digitalized vision.

PEOPLE

FIRST & LAST MILE SHARED AUTONOMOUS TRANSPORTATION IN COLLABORATION WITH BUSSES

Ford envisions to democratize mobility. The essence of public transport is that everyone should have access to some form of transportation. I think those two believes should be matched together.

TARGET GROUP

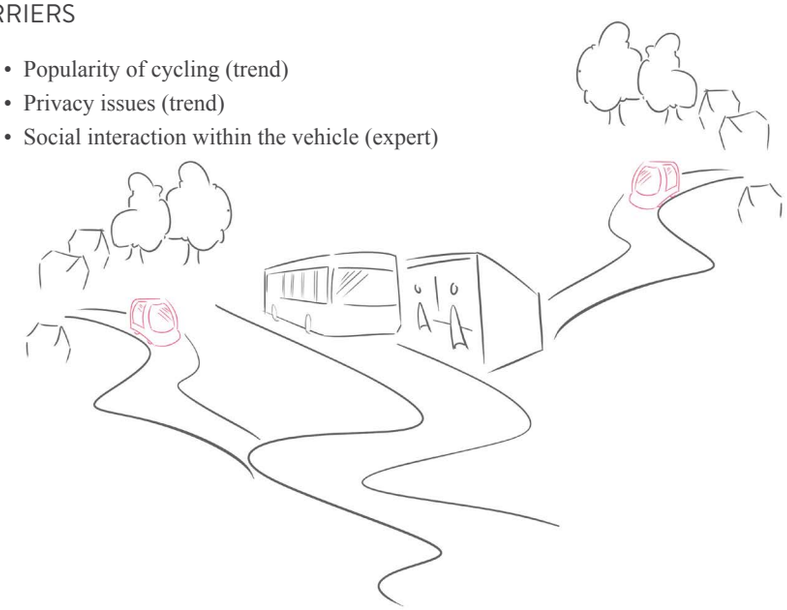
- Urban visitors
- Urban habitants

DRIVER

- Urbanization – limited space (development)
- Mobility as a service (trend, Ford, NS, ProRail, Arriva)
- Sharing economy (trend)
- Demotorization (trend)
- Time is value (trend)
- Bus will travel more frequent with less stops (NS, ProRail, Arriva)
- Democratizing mobility (Ford)
- Mobility on Demand (trend)

BARRIERS

- Popularity of cycling (trend)
- Privacy issues (trend)
- Social interaction within the vehicle (expert)



AUTONOMOUS SHARED VEHICLES FOR ASSISTING BUSSES IN PEAK HOURS OR REPLACING BUSSES IN OFF PEAK HOURS

Urbanization causes major pressure in our current infrastructure. There is not enough space and streets face enormous congestions. Therefore, the dependence on public transport is increasing and should be attractive. Ford should assist the efficiently and experience of current bus transportation.

TARGET GROUP

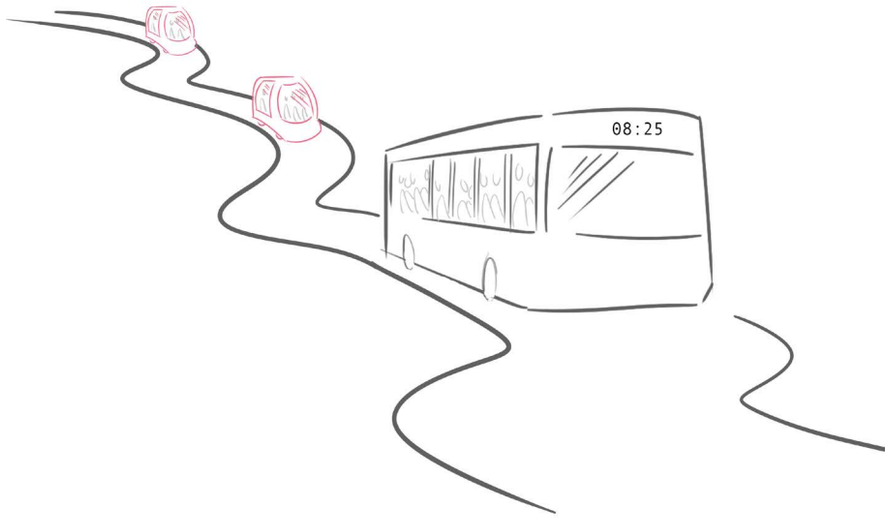
- Commuters

DRIVER

- Urbanization – limited travel space (development)
- Mobility as a service (trend, Ford, NS, ProRail, Arriva)
- Attractiveness of public transport (NS, ProRail, Arriva, Eindhoven)
- Mobility on Demand (trend)

BARRIERS

- Collaboration with stakeholders (Arriva)



DEDICATED AUTONOMOUS AREAS (ZONE C)

To increase popularity of public transport, mobility should be accessible in highly used (industrial) areas such as university campuses. Also, links between those areas are important as industry often works closely with institutes. Busses are often no viable option, they only provide mobility from-, and towards the central station. Dedicated areas between industries and/or institutes also create a perfect opportunity for testing the technology.

TARGET GROUP

- Urban visitors
- Commuters

AREAS

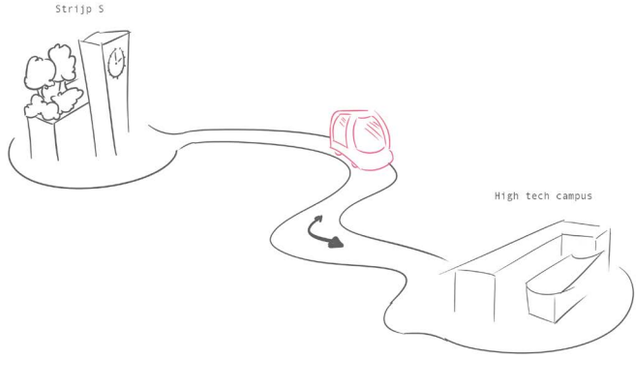
- Industrial areas (Strijp S, High-tech campus)
- Campus (TU Eindhoven)
- Connection between those areas

DRIVER

- Mobility as a service (trend, Ford, NS, ProRail, Arriva)
- New work (trend)
- Urbanization (development)
- Sharing economy (trend)
- Mobility on Demand (trend)

BARRIERS

- Ownership will not disappear in zone C (experts)



COMMUNITY SHARING SERVICES

Although Eindhoven has enough parking spaces (for now), car ownership in urban areas should decrease. Municipalities are creating regulation towards sharing services (i.e., increase parking costs). As electric autonomous vehicles will be cheaper than car ownership, multiple car-ownership households will decrease. Ford should do research in areas where a sharing mind-set is accepted and stimulated (i.e., Strijp S in Eindhoven).

TARGET GROUP

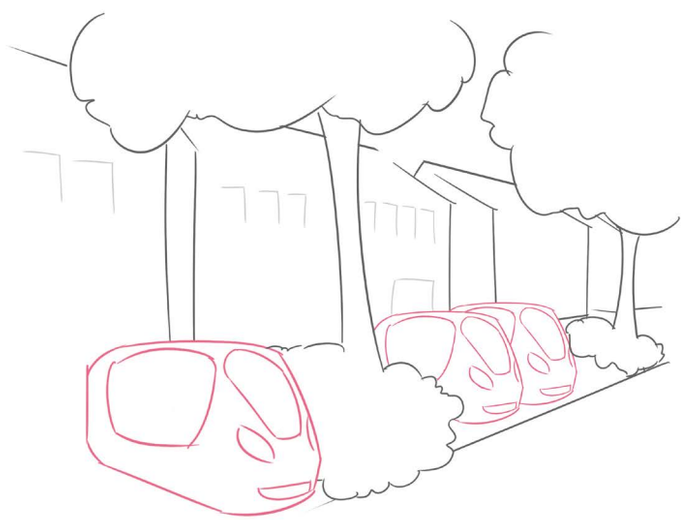
- Urban habitants

DRIVER

- Urbanization – limited (parking) space (development)
- Stakeholder willingness (Spaarnelanden, Eindhoven)
- Sharing economy (trend)
- Demotorization (trend)
- Chariot (Ford)
- Participation society (trend)
- Mobility on Demand (trend)

BARRIERS

- Decrease in flexibility and independency (experts)



NEW TARGET GROUPS

Currently, vehicles can only be driven by humans with a driver's licence. Autonomous technology enables mobility for other target groups that first could not use those kinds of vehicles. Although new target groups open up a lot of unanswered questions, it is still important for Ford to investigate this direction as it fits their vision: democratizing mobility.

ELDERLY

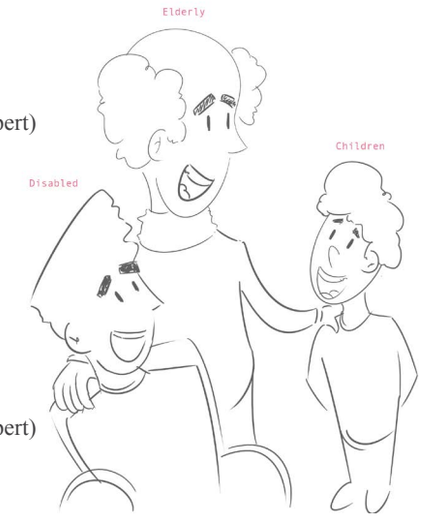
- **Divers**:
  - o Silver society (trend)
  - o Anonymity and loneliness (trend)
  - o Quality of life (trend, Eindhoven)
  - o Democratising mobility (Ford)
- **Barriers**:
  - o First & last meter transportation (expert)

DISABLED

- **Divers**:
  - o Silver society (trend)
  - o Anonymity and loneliness (trend)
  - o Quality of life (trend, Eindhoven)
  - o Democratising mobility (Ford)
- **Barriers**:
  - o First & last meter transportation (expert)

CHILDREN

- **Drivers**:
  - o Democratizing mobility (Ford)
  - o Time is value (trend)
  - o Mobility as a service (trend, Ford, NS, ProRail, Arriva)
- **Barriers**:
  - o Privacy issues (trend)
  - o Responsibility and control (expert)
  - o Quality time with children (expert)



PROVIDING THE PLATFORM FOR MOBILITY AS A SERVICE

This direction is ambitious and uncertain. Every provider of mobility wants to stay in close connection with their users. If you do not own the main-accepted platform, you risk losing that connection. Ford is often seen as a reactive company with automotive innovation (e.g., in comparison with Tesla). As Ford is the first with the clear vision of democratizing mobility and giving the streets back to community, they are in the position to offer this platform.

TARGET GROUP

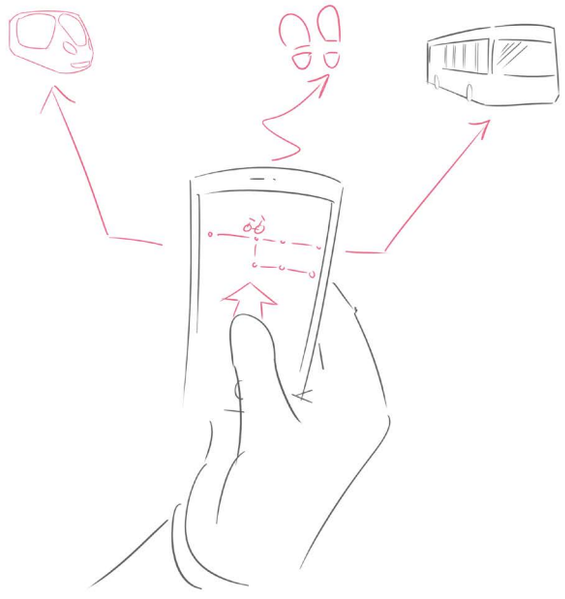
- Urban citizens

DRIVER

- Democratization mobility (Ford)
- Mobility as a service (trend, Ford, NS, ProRail, Arriva)
- Platform design (trend)
- Sharing economy (trend)
- ‘Transportation Mobility Cloud’ (Ford)
- Open innovation (trend)

BARRIERS

- Competition of other parties (i.e., Google)
- First to market importance
- Start-up culture (trend)



INDIVIDUAL AUTONOMOUS VEHICLE

On a society level in urban areas, there is too little space for individual mobility. The benefits in a user level are still very clear (e.g., more time to do what you want to do). Therefore, outside zone A and zone B, individual autonomous vehicles are a viable investment. Ethically seeing, Ford should watch out that not more vehicles will enter the street.

TARGET GROUP

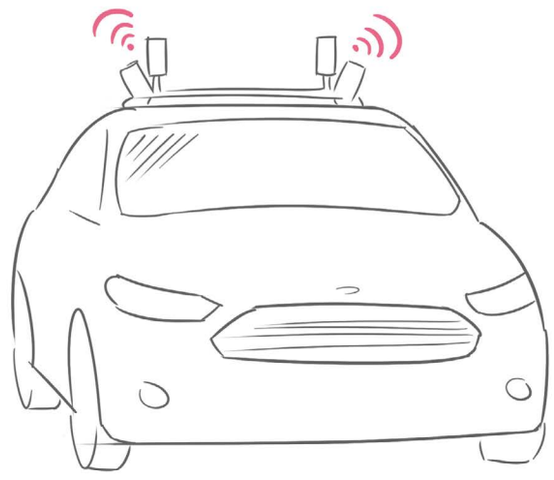
- Car ownership customers (high-end) in zone C or rural areas.

DRIVER

- Time is value (trend)
- Quality of life (trend)

BARRIERS

- Congestions (development)
- Demotorization (trend)



AUTONOMOUS TAXI'S

Services often have a premium version (i.e., Spotify and NS first class). For shared autonomous vehicles, this will also be the case. Although this kind of mobility will still have its restrictions in zone A of the city, a variety of business models for shared autonomous vehicles will come to market.

TARGET GROUP

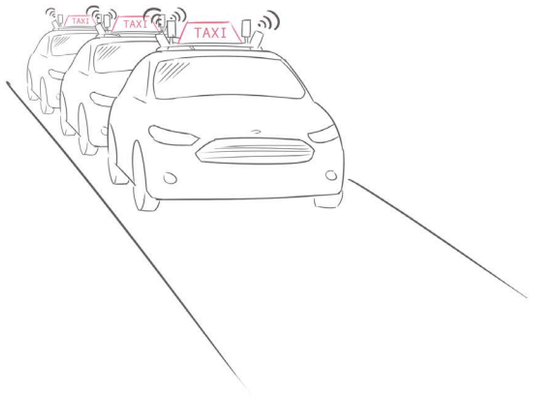
- Premium public transport users
- Urban visitors

DRIVER

- Mobility as a service (trend, Ford, NS, ProRail, Arriva)
- Unequal wealth distribution (development)
- Time is value (trend)
- Mobility on Demand (trend)

BARRIERS

- Social bubble effect (development)
- Zombie vehicles (driving vehicles without people or cargo)



MOBILITY HUBS

Public transport often does not transport you from A to B in one mode. As Ford is entering the sector of public transportation (with collaboration with busses and sharing vehicles), they should think and (re)design transition hubs from one mode to another. Transition of one mode to another are often seen as uncomfortable of inefficient. Digitization and close collaboration of mobility modes and stakeholders can help. An example could be an autonomous shared vehicle driving through the rail tunnel and on the platform where the train is standing (idea provided by NS).

TARGET GROUP

- Users of public transport
- Urban visitors and inhabitants

DRIVER

- Demotorization (trend)
- Mobility as a service (trend, Ford, NS, ProRail, Arriva)
- Stakeholder willingness (NS, ProRail, Arriva)
- Urbanization (development)

BARRIERS

- Customer experience (expert)
- New parking spaces (Eindhoven)

GOODS & SERVICES

AUTONOMOUS GOODS DELIVERY (ZONE C)

"Delivery in the future by a person could be something luxuries, at your birthday for example" (PostNL session). This shows the level of commitment towards autonomous delivery. Although not so feasible in urban centres (to little space on infrastructure), autonomous delivery can be a very viable option for Ford to invest in.

TARGET GROUP

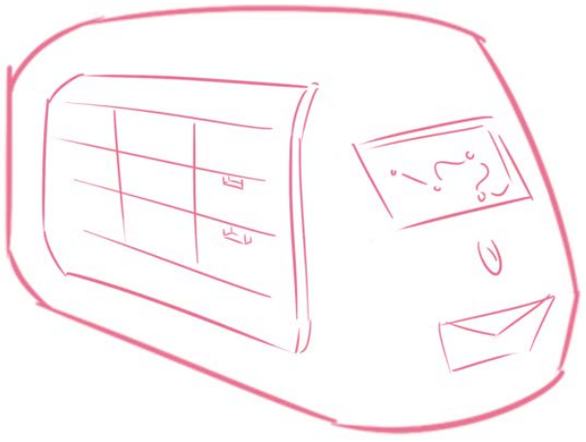
- Delivery organisations in zone C (when people are home)

DRIVER

- New mobility innovation (trend)
- Efficiency (DHL, PostNL)
- Less pressure on infrastructure (Eindhoven)

BARRIERS

- Customer service (Picnic, PostNL)
- Cargo safety (expert)



AUTONOMOUS PICK-UP POINTS

People see the responsibility that follows after making a delivery appointment annoying. Therefore, pick-up points can be a desirable option as people can pick-up their package whenever they want. In centre centres (zone A & B), pick-up points will be in popular buildings or public transport hubs. In suburbs, mobile pick-up points can be delivered and picked-up as a whole and replaced. Therefore, efficient delivery is made close to the customer.

TARGET GROUP

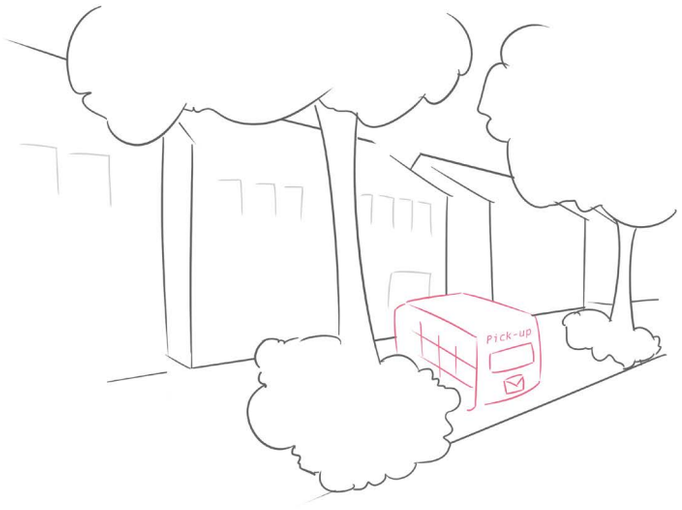
- Delivery organisations in zone C (when people are not home)

DRIVER

- Flexibility for the customer (DHL, PostNL)
- New mobility innovation (trend)
- Efficiency (DHL, PostNL)

BARRIERS

- Requires space
- Longer last mile



COMMUNITY SHARING VEHICLES

The sharing community is a promising development that can be further exploit. Peerby (www.peerby.nl) is a popular Dutch platform that allows for sharing of little used products in neighbourhoods. As Ford wants to increase liveability and community life, this is perfect local initiative that could be provided. This vehicle could also be used to increase safety and ‘keep-an-eye’ on the streets.

TARGET GROUP

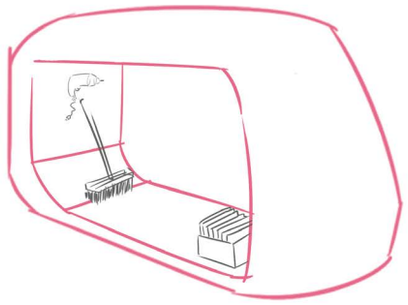
- Communities

DRIVER

- Sharing economy (trend)
- Meaningful innovation (Ford)
- Equal value distribution (analysis)
- Social cohesion (expert)

BARRIERS

- Management of fleet (expert)
- Viability (Ford)



CONSTRUCTION & MAINTENANCE

AUTONOMOUS COMMERCIAL VEHICLES

The biggest trouble construction or maintenance workers have in cities safety and space. Therefore, the commercial vehicles of Ford can get an upgrade. The vehicle not only functions as storage, but also as workspace that communicates to the environment.

TARGET GROUP

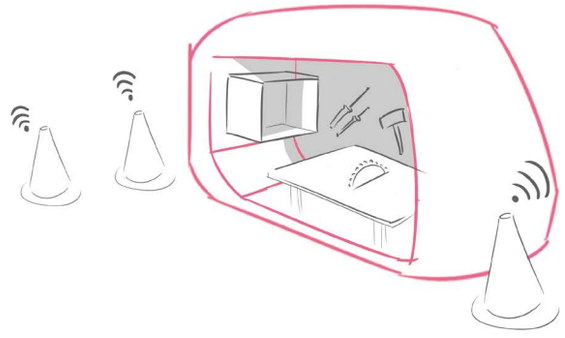
- Construction or maintenance workers in urban area

DRIVER

- Safe working place (HaagWonen)
- Space efficient (HaagWonen, Eindhoven)

BARRIERS

- Change management of construction organisations
- Flexibility of autonomous vehicle, feasibility (Ford) ■



3. NO GO'S

There are already a lot of future visions on mobility available (see Appendix E). There are some strong ideas and directions but I do not agree with all of them. After all conversations with experts and stakeholders, I disagree with the following concepts.

Expansion of delivery service experiences

In my opinion, inside vehicle delivery (shopping) experiences are not a valuable option. People want to have the full experience of shopping (in the city) or having the efficiency of delivery. Can you imagine going out on the street (e.g., while at work, or in the evening at home) and taking the time to fit several shoes or other pieces of clothing? I can imagine that online shopping experiences will improve (e.g., augmented reality shopping), but not a within-vehicle-shopping experience.

Autonomous drone delivery (in urban areas)

As global warming is a major driver for companies to change their emission, drone delivery will take too much energy for one package (confirmed by DHL and PostNL). In rural areas, where sometimes deliveries happen for only one or two households, drone delivery could be more sustainable (confirmed by PostNL).

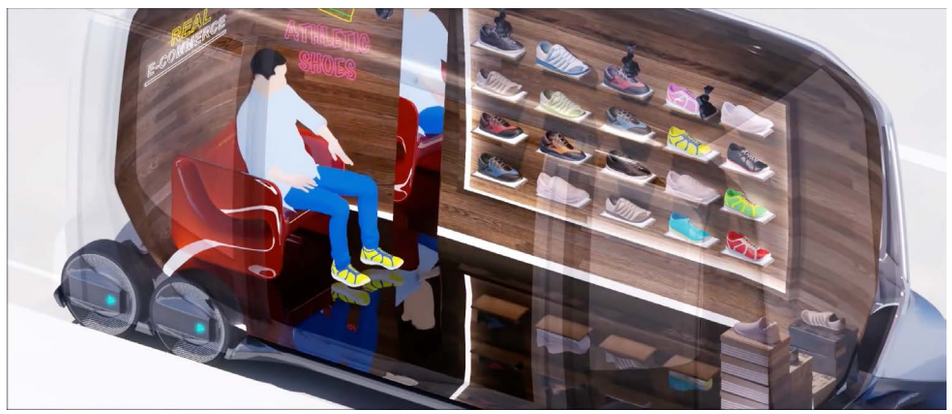


Figure 52. Toyota's e-Pallete concept

Individual autonomous transportation in zone A and zone B

Although private individual mobility will not disappear, municipalities will try to move them away from city centers as there is little space in zone A and zone B. As this is a transition, autonomous vehicles will be able to drive there until municipalities have implemented those regulations. For Ford, it could still be beneficial to produce individual autonomous cars (they will be driven anyway). It could be interesting, within this transition, to invest in very small individual autonomous mobility as it takes in less space.

Figure 53. Drone delivery in cities

Zombie vehicles

Today, cars cost a lot of money if they are standing still (e.g., parking). With electric mobility, it costs less to let your autonomous car drive around the block, then to park it somewhere. Regulations from governments and municipalities should prevent this from happening. Ford can take a proactive approach against this dystopia. ■

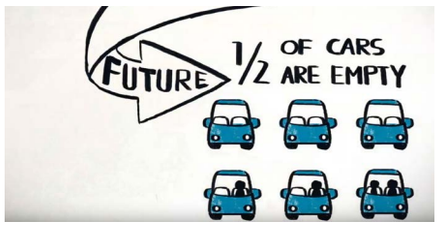


Figure 54. Empty cars that drive around the city

4. PERSONAL RECOMMENDATIONS

To conclude this part, I foresee several opportunities for Ford to further invest in. For future research, I have chosen three opportunities which I think have the most added value (see Figure 55).

First & last mile shared autonomous transportation in collaboration with busses.

Personally, I think this solution fits perfect with the vision of Ford and of interviewed stakeholders. Also, this direction helps urban areas face challenges such as congestions and scarcity of space (see Figure 56).

Important drivers:

• The vision of public transport that busses will travel more frequent and with less stops. This will increase first and last mile transportation and creates an even bigger opportunity for Ford.

• As this mobility solutions will increase the popularity of public transport and shared mobility, this will decrease the need of parking spaces and ownership of vehicles.

• As busses will decrease mobility in some areas (but eventually increase their service experience as their research suggests), Ford can carry out their vision of democratizing mobility. Extending their services to areas where public transport does not reach, or to people who cannot reach public transport.

First steps:

• Focus on urban public transport organizations (e.g., Arriva and Connexion) and validate the vision created in this thesis.

• Determine target groups and execute user research on specific needs for first and last mile transportation. Important questions would be:

- How can shared mobility on demand create the same benefits as ownership of a vehicle?

- What target group would benefit the most from this mobility solution?

• Determine the business case of the solutions. How many trips does a shared autonomous vehicle need to make in order to make profit? Also, how large does the vehicle needs to be in order to accommodate all demand? ➤

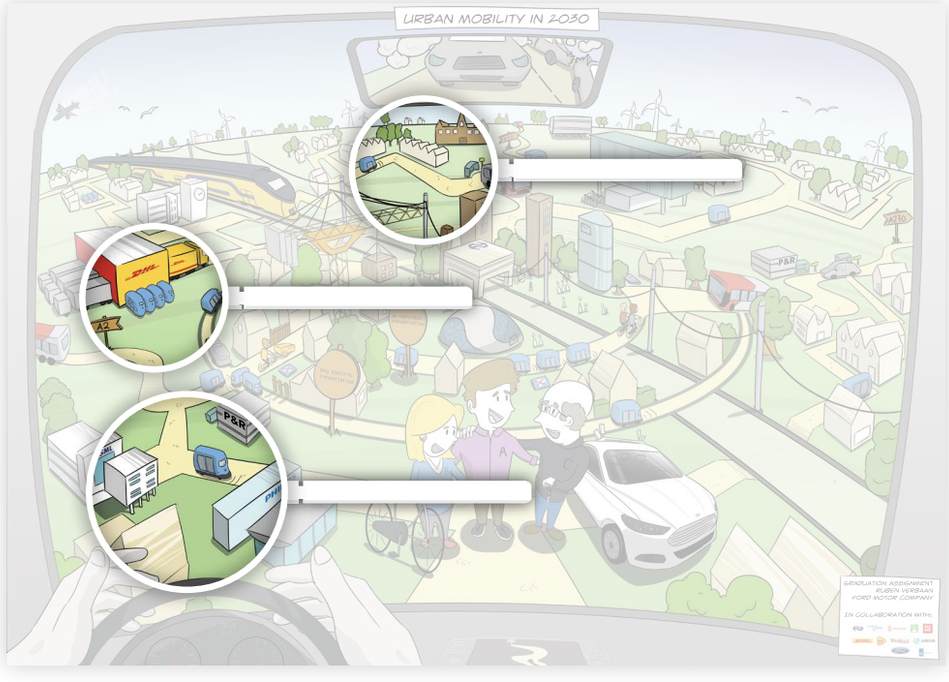


Figure 55. Recommendations are visible in the vision

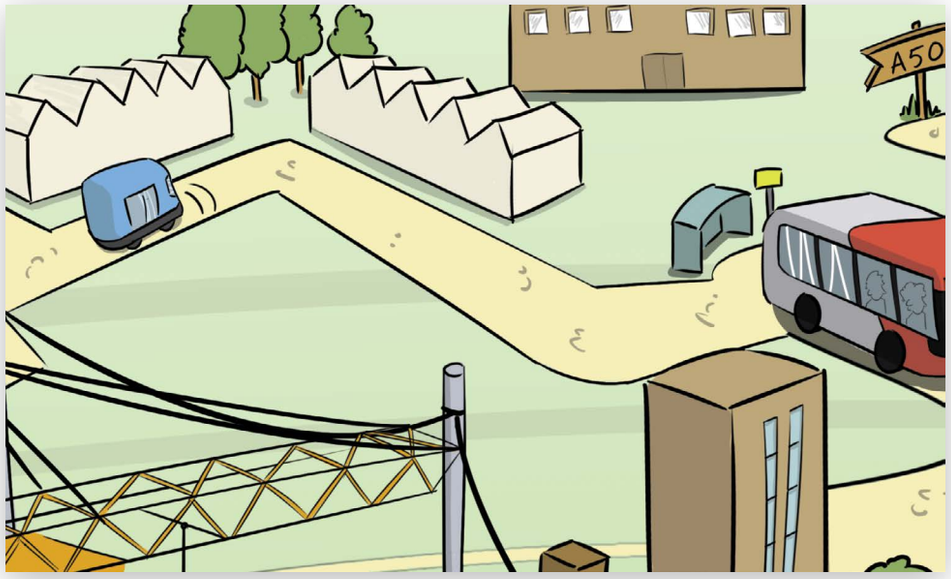


Figure 56. First and last mile shared transportation in collaboration with busses

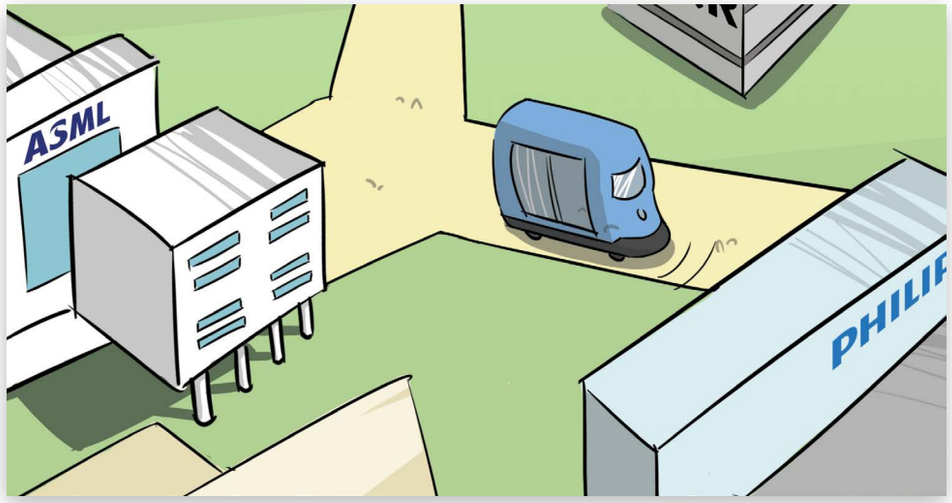


Figure 57. Dedicated autonomous areas (zone C)

Dedicated autonomous areas (zone C)

To increase popularity of public transport, dedicated areas for autonomous vehicles could make it more attractive for commuters to remove their personal vehicle. I believe this is a valuable direction for Ford to test their first autonomous vehicles. Moreover, local participation is key for optimal implementation of this direction, which aligns with my vision for Ford.

Important drivers:

• The municipality of Eindhoven confirmed their interest in new mobility solutions at the second session together with Ford. They are investing in new infrastructure which they want to design future proof. This means as flexible as possible, so new mobility solutions can be implemented (e.g., autonomous vehicles).

• Industries in Eindhoven (e.g., ASML) accommodate a lot of foreign employees who (often) enter this country without a vehicle. If shared mobility solutions are available, these employees will be more inclined to use it as they will not have to invest in vehicle ownership. ASML is currently in need of parking spaces as they are growing rapidly, that demand would decrease if Ford could offer sharing services such as Chariot.

First steps:

• Focus on collaborating with the municipality of Eindhoven in order to asses which companies (e.g., ASML) are in need of parking spaces or shared mobility solutions.

• Research if service such as Ford Chariot are a viable option. As Chariot still demands a driver, maybe the service will only be viable with autonomous technology.

• This solution can easily be transferred to other cities, as long there is a demand between industries where public transport does not offer enough coverage.

Figure 58. Autonomous delivery of goods (zone C)

Autonomous delivery of goods (zone C)

The amount of goods that are being delivered is still growing. The delivery industry is innovating in the type of vehicles they need in order to efficiently deliver all type of goods. In zone A and B, bicycle delivery and pick-up points will be dominant over delivering with a vehicle. Therefore, zone C will be the main focus point for Ford.

Important drivers:

• Stakeholders (PostNL and DHL) say that the logistic business is all about efficiency (up to seconds). Therefore, autonomous delivery could dramatically increase costs as they do not need personnel anymore.

• Stakeholders also confirmed they have a large shortage in delivery personnel (the Dutch populations is relatively to highly educated), autonomous delivery could help filling this gap.

• E-commerce and the sharing economy are gaining massive proportion. Therefore, Ford could see this as a viable investment.

First steps:

• Ford is already collaborating with DHL for the chassis of the delivery vehicle. I would suggest to extent that collaboration towards customer services in order to optimize the total vehicle for it.

• As pick-up points are preferred in zone A, this does not mean it cannot be a viable option in zone C as well. Therefore, research should be done on a vehicle that could service as a delivery model and a pick-up point model at the same time. ■

CONCLUSION

To conclude my thesis, I shortly explain the main findings of my research and design phases. Also, I look back on the research question stated in the beginning of my thesis. Finally, I advise Ford and the University Research Project (URP) on next steps for this project and future innovation.

1. CONCLUSION

This thesis set out to find strategic mobility solutions for Ford Motor Company to create opportunities with new technological innovations in the mobility industry. Especially autonomous technology enables Ford to diverge and disrupt the current modes that are available in the market. Therefore, the main research question of this thesis was:

How can Ford prepare itself and design for the disruptive technology of autonomous vehicles within the mobility ecosystem of 2030?

In order to answer this question, I did research on the mobility ecosystem, the urban environment and technological innovations in the mobility industry (with focus on autonomous technology). Trends derived from this research together with experts in the field of mobility enabled me to create a vision on future urban mobility. The vision is iterated with multiple stakeholders within the ecosystem in order to iterate and validate this vision. From this vision, strategic mobility solutions are designed for Ford in order to stay ahead in the mobility industry.

There are three main findings from this thesis. The first two are from Part A: Design context, and the third are solutions (Part D) that fit Ford's new direction as mobility provider.

Main finding 1: **Servitization of Ford**
Ford's vision is to democratize mobility and give the streets back to the community. In order to deliver this promise, Ford needs to change from a product-centric mind-set to a service-centric mind-set. This transformation is called servitization. If Ford wants to offer Mobility as a Service, they need to collaborate with stakeholders in the mobility ecosystem.

Main finding 2: **How to create value in the mobility ecosystem**
There are different variables that are influenced by changing values in the mobility ecosystem.

1. Mobility stakeholders (government, institutes, industry, and citizens)
2. Mobility users (people, goods & services, construction & maintenance)
3. Different urban zones (downtown, pre-war and the suburbs)

If Ford wants to create value in the mobility ecosystem, they need to define in which urban zone and for which user they want to design. With this focus, Ford needs to collaborate with existing mobility providers and mobility stakeholders in order to increase the quality of life as much as possible.

Main finding 3: **New mobility solutions for future urban mobility**
If Ford wants to achieve their vision, they can achieve this by introducing new mobility solutions in urban areas where pollution and congestions are the worst. For this assignment, new mobility solutions are designed for the city of Eindhoven, as they have a car friendly infrastructure, is not too large for a pilot and stakeholders are very willing to support new Smart Mobility innovations. I recommend the following three mobility solutions:

1. First & last mile shared autonomous transportation in collaboration with busses (mobility across zones)
2. Dedicated autonomous areas (zone C)
3. Autonomous goods delivery (zone C)

The mobility solutions can only be fully beneficial if all three mobility innovations (electrification, digitization and autonomous technology) are available and implemented.

To conclude, if Ford wants to offer Mobility as a Service, they need to co-create this with relevant stakeholders in the mobility industry, while keeping in mind the different variables in the ecosystem. This is the main takeaway for Ford to prepare themselves for the disruptive technology of autonomous vehicles in the future mobility ecosystem. ■

2. WHAT'S NEXT?

In order for Ford to continue with this project, two next steps are proposed. First, an advice for the Ford Mobility Research (FMR) department in Aachen and second, a proposition is made on the next steps for the University Research Project (URP).

Other cities

Eventually, the mobility solutions that I suggest are for the city of Eindhoven. Cities in Europe are somehow similar (comparing to the United States for example). If Ford wants to use this method for other cities, the following information can be generalized.

1. Mobility stakeholders (government, institutes, industry, and citizens). The different stakeholders are present in most cities, although their precise value exchange can differ. Insights from specific institutes or government offices cannot be used for other countries. One of the first things Ford should investigate is how open municipalities are for new innovative mobility solutions and if current mobility providers want to collaborate.

2. Mobility users (people, goods & services, construction & maintenance).

3. Different urban zones (downtown, pre-war and the suburbs). I believe that every city has different zones which demand different mobility solutions. Although European cities are known for their historic downtown zones, cities outside Europe can also be mapped. For urban mobility and especially for an urban autonomous shared vehicle, close collaboration is needed in order to tailor specific needs.

Also, Ford should stay in contact with institutes or consultants who investigate country/ city readiness for autonomous mobility solutions. An in-depth look into the reports of KPMG (2018) or Giffinger et al., (2014) are useful when deciding where to invest resources in.

Method and vision

Not only the insights, but also the method can be reused in order to create a shared vision among stakeholders. In order for the correct execution of this method, an in-house designer is recommended. As explained in Part A, designer have the preferred skills to collaborate with stakeholders and formulate such a complex vision.

For the vision that is currently created for the city of Eindhoven. The department at Ford Aachen (Ford Mobility Research) is responsible to propagate this vision internally and decide how to use this in order to align future stakeholders.

Next steps for Eindhoven
If Ford wants to continue this specific project, first actions to take would be to contact the stakeholders and validate the vision I created. Second, research should be done on the following topics:

- **Feasibility** of the mobility solutions (is Ford able to produce such a product?)
- **Desirability** of the mobility solutions (we know that stakeholders want such as product/ service, but what kind of users does Ford want to attract and what are their specific needs?)
- **Viability** of the mobility solutions (how can Ford profit from this solutions and what kind of business models are possible?)

Quick wins

My project was for the year 2030. During the different sessions and conversations I had, several organizations already showed interest in opportunities today.

- **Spaarnelanden** is investing in sharing community vehicles and wants to start their pilot in April 2018. As Ford shares part of Spaarnelanden's vision (giving the streets to the community), this is an opportunity.
- **ASML** is currently growing and hiring a lot of expats in Eindhoven for their business. ASML sees a large shortage in parking spaces and mobility solutions for their foreign employees to commute. Ford could invest of a sharing service such as Chariot is viable.
- **DHL** is fully investing in autonomous technology and already working together with Ford today. As the Netherlands is DHL's pilot country for innovation, initiatives around Eindhoven can be a fruitful testing ground.

URP

This thesis included multiple stakeholders and other mobility providers. It gave valuable insights in the design for ecosystems. The next step should be an in-depth user research on chosen target groups and a chosen context. As it is difficult for users to predict needs for radical innovation, context mapping session should be held in order to derive latent needs and values. A designer can translate those needs and values into concrete product or services accordingly. Different directions for urban mobility can be:

• People transport, first and last mile mobility in collaboration with public transport.
• People transport, mobility coverage in industrial areas where there is little public transport.
• Goods delivery, first and last meter transportation of good and different values for delivery and pick-up points.

When new directions are chosen, it is important to keep involving relevant stakeholders for each assignment (e.g., Arriva or the municipality of Eindhoven). The jumpstart new graduation projects, a session to fully understand the vision described in Part C2 is recommended. ■■

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